IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF WEST VIRGINIA
AT CHARLESTON

OHIO VALLEY ENVIRONMENTAL COALITION, INC., WEST VIRGINIA HIGHLANDS CONSERVANCY, INC., and SIERRA CLUB,

Plaintiffs,

v. CIVIL ACTION NO. 2:13-5006

FOLA COAL COMPANY, LLC,

Defendant.

Huntington, West Virginia
August 21, 2014

TRANSCRIPT OF BENCH TRIAL - DAY 3
BEFORE THE HONORABLE ROBERT C. CHAMBERS
UNITED STATES DISTRICT JUDGE

APPEARANCES:

For the Plaintiffs:

J. MICHAEL BECHER, ESQ.
JOSEPH M. LOVETT, ESQ.
APPALACHIAN MOUNTAIN ADVOCATES
P. O. Box 507
Lewisburg, WV 24901

JAMES M. HECKER, ESQ.
PUBLIC JUSTICE
1825 K Street, N.W.
Washington, DC 20006

For the Defendant:	ROBERT G. MCLUSKY, ESQ. M. SHANE HARVEY, ESQ. MATTHEW S. TYREE, ESQ. JACKSON KELLY 1600 Laidley Tower P. O. Box 553 Charleston, WV 25322
Court Reporter:	Teresa M. Ruffner, RPR Sidney Christie Federal Building 845 5th Avenue, Room 101 Huntington, WV 25701 (304) 528-7583

Proceedings recorded by mechanical stenography; transcript produced by computer-aided transcription.

Thursday, August 21, 2014, at 9:05 a.m. in open court

THE COURT: All right. Are we ready to resume with the examination of the witness?

MR. HARVEY: Yes, Your Honor.

THE COURT: Miss Kuehn, if you'll take the stand again.

BY MR. HARVEY:

Q. Good morning, Miss Kuehn.

A. Good morning.

Q. Sleep well?

A. I did. I slept very well. Thank you.

Q. You're under oath now.

A. I did sleep well. I slept a long time last night.

Q. All right. Yesterday you and I began to talk about data quality, which drew an objection from Mr. Lovett. Do you recall that?

A. Yes, I do.

Q. And I just want to clarify. You are not saying or testifying today that the data that EPA or DEP gathered is inaccurate in some way in terms of measurement, are you?

A. No, I'm not.

Q. So that you're not saying the temperature measurements are wrong, for instance.

A. Correct, that's not what I'm saying at all.

Q. You're just saying that the data is coarse. It has

limitations, correct?

A. That's correct. So limitations in the data will translate into limitations --

MR. LOVETT: Objection, Your Honor. This calls -- even to know whether the data are coarse or not calls for ecological knowledge that this witness does not have.

THE COURT: Well, you can cross-examine her about this. I'm going to deny the objection. I went back and looked at her report actually yesterday during her testimony. The first opinion she offers is that temperature may confound the statistical association between conductivity and the benthic community based on data from the DEP. The report goes on to elaborate about that.

I think clearly she identified temperature as a confounding factor based on statistical analyses that an epidemiologist can perform. So I'm going to let her testify about that.

MR. LOVETT: I don't disagree, Your Honor, that that is in her report. I don't think she's competent to testify about it, and in her deposition she said that she was not going to testify about it.

THE COURT: Well, I don't know that she's testified beyond what I've just described. Do you think --

MR. BECHER: Your Honor, if I may, the problem with her report is that when we asked her about those sections, she

said that she was not able to answer questions about those sections of her report, those figures in her report, and we should direct those questions to Dr. Menzie.

MR. HARVEY: Your Honor, if you look at her deposition -- we can put parts of it on the screen if we need to. She testified that she would not talk about the quality of the data in terms of its accuracy. She said there are limitations in the data throughout the deposition with Mr. Becher or Mr. Lovett, that it's seasonal and it has different variabilities, it should -- there should be time-sensitive analysis on the data. She talked about that at length throughout the deposition.

THE COURT: Well, I deny the objection. At this point I'm satisfied it's within her report.

BY MR. HARVEY:

Q. Before we resume our discussion of table -- I think it was B-20 in the EPA benchmark -- I wanted to clear up one thing.

Yesterday we talked about a relationship between temperature and conductivity. Do you recall that?

A. Yes, I do.

Q. You were not saying that one causes the other, correct, that temperature causes conductivity to go up or conductivity causes temperature to go up?

THE COURT: I think this is where you need to be

careful because this sounds like you're asking for an opinion that could be an aquatic ecologist's opinion rather than an epidemiologist's. So if you'll rephrase your question and focus on her opinions based upon the statistical analyses that an epidemiologist would perform, I'm satisfied that's within her expertise.

MR. HARVEY: I'm actually trying to limit her testimony to make it clear she was not talking about that, Your Honor.

THE COURT: Okay.

THE WITNESS: Yeah, that's correct. I was not implying that at all.

BY MR. HARVEY:

Q. Okay. And you weren't saying that temperature changes daily and conductivity tracks it on a daily basis, for instance?

A. I'm not saying the two are causally related in any way. I'm saying that there is evidence that they are related in some way based on the graphical analysis that I've looked at that would lead me to be concerned that temperature is a potential confounder of the relationship between conductivity and impairment and thus it needs to be evaluated as such in the analyses.

Q. Understood. Mr. Tyree, could we go back to table B-19? B-19, Mr. Tyree. And for the record, this is Joint Exhibit

58, page 492.

Miss Kuehn, we were talking about this table when we left yesterday. Do you recall that?

A. I do.

Q. And we talked about certain limitations in this table. Do you recall that?

A. Yes, I do.

Q. And I don't want to cover them all again, but just to get everyone back up to speed, you talked about this table being based on snapshot data. Do you recall that?

A. That's correct.

Q. And that's a limitation, correct?

A. Yes, absolutely.

Q. And you talked about the fact that the -- we do not know whether the habitats are the same between these two conductivity bins?

A. That's correct.

Q. So we don't know if we're comparing apples to apples, correct?

A. That is correct.

Q. And you talked about the fact that there are only two discrete groups in the table, very low conductivity and very high conductivity, correct?

A. That's correct. We're missing a lot of information in this table.

Q. And I can't recall if we talked about this in depth, but you also had a concern -- I believe you mentioned that EPA switched the outcome of interest. Do you recall that?

A. That's correct. It's important that when you're doing an analysis and you're assessing confounding, that you're very clear what your exposure is and what your outcome of interest is. And all of your assessments, all of your analyses that you do need to be based on that same outcome.

So switching between presence and absence of bugs, to the number of taxa you see, to an assessment of impairment such as WVSCI, those are three completely different outcomes.

Now, you can evaluate those relationships with conductivity with each of those outcomes, but if you're evaluating confounding, you need to do it for each of those relationships within its own analysis. You can't switch.

So if we identify a potential confounder of conductivity and presence or absence of bugs, that may not have the same confounding effect on the relationship between conductivity and impairment as measured by WVSCI. It needs to be specific to the relationship of interest.

So EPA kind of flips back and forth with the outcomes that they present in this appendix.

Q. In fact, this table only tells us at each site or for each bin, if you will, whether one mayfly was present or absent, correct?

A. That's correct.
Q. It doesn't tell us anything about whether the WVSCI scores were passing, correct?
A. That's correct.
Q. Or anything about the species sensitivity distribution that EPA talks about in the benchmark, correct?
A. That's correct.
Q. I'd like to go back to table B-20, which is EPA's confounding factor analysis for temperature. It's on the next page of the benchmark, I believe.
There is a step 7 to table B-20. Do you recall that?
A. Yes, I do.
Q. Miss Kuehn, what is EPA doing in step 7?
A. They're reporting on what appears to me a multivariate model where they included habitat quality, temperature, and fecal coliform in what they describe as a multiple regression.
Q. And do they refer to table B-7? Is that correct?
A. That's correct.
Q. Mr. Tyree, would you put table B-7 on the screen?
For the record, that is Joint Exhibit 58, page 482.
This is the same multiple regression that we talked about earlier, isn't it, Miss Kuehn?
A. That's correct.
Q. This is the multiple regression that EPA put in the benchmark to respond to the SAB's concerns, correct?

A. I don't know if it was to respond to SAB, but it is included in the benchmark, yes.
Q. And we talked about the flaws in that multiple regression analysis earlier, correct?
A. That's correct.
Q. I don't want to cover those again, but let me ask you this. Would you use this multiple regression analysis with all its flaws to discount temperature as a confounding factor?
A. No, I would not.
Q. I'd like to next turn to Joint Exhibit 58, page 483, which is table B-9 -- which contains table B-9. And this is a similar analysis of confounding performed by EPA in the benchmark, correct, except this one is for habitat? Correct?
A. That's correct.
Q. Okay. And there are similar -- similar to the temperature confounding analysis, there are various steps that EPA walks through; is that correct?
A. That's correct.
Q. Okay. What are they doing in the first step?
A. Again, they are evaluating the correlation between RBP scores, the measure of habitat, and conductivity.
Q. And they found a positive relationship?
A. Yes, they did. Well, they scored it as a plus. They found a negative correlation coefficient of 0.25.
Q. And the second step, they gave a positive score, correct?

A. That's correct.
Q. Based on a moderate correlation between RBP and number of mayfly?
A. That's correct. But I would note again that the count data for the number of flies would not have a linear relationship with RBP. So doing a correlation there is somewhat misleading. But that's what they did.
Q. And then in step 3, they use a contingency table much like the one we talked about for temperature?
A. That's correct.
Q. Did it contain similar flaws?
A. Yes. All of the confounding analyses that EPA did are similar to what we see in this table, as well as the one for temperature, and they repeat the same mistakes.
Q. And they rely in step 7 on the same multiple regression analysis that is flawed, correct?
A. That's correct.
Q. And we've already talked about those flaws, correct?
A. Yes, sir.
Q. And at the very bottom, there's a weight of evidence statement. Do you see that?
A. Yes, I do.
Q. And the last sentence says, "Therefore, we did not correct for habitat, but more detailed habitat studies could be worthwhile."

A. Yes, I see that.
Q. Does this make any sense to you?
A. It's somewhat baffling. They disregard the evidence they have in front of them that habitat could be not just a confounder but what we would call an effect modifier, which is something that is not adjusted at all in the EPA report. But they note that they should do more work looking at habitat. So it's somewhat contradictory.
Q. Would a competent epidemiologist eliminate habitat as a confounder under these circumstances?
A. No. I would have done much more evaluation of habitat as a confounder and a potential effect modifier of the relationship of interest.
Q. Would a competent epidemiologist eliminate temperature as a confounder based on the analysis we discussed earlier?
A. Not at all, no.
Q. And the analysis for all of the confounding factors in the benchmark under appendix B are done similarly, correct?
A. Yes. They are all done using the similar weight of evidence technique that EPA seems to have developed on their own. None of the methods that they used to look at confounding would have successfully identified confounders, certainly would not have eliminated confounding, nor would it have appropriately controlled for confounding of the relationship between conductivity and impairment.

Q. What would be the proper way to address confounding in a situation like this?

A. We would start with the whole dataset. We would use a priori knowledge. EPA provides some good a priori knowledge in --

Q. Let me stop you there.

A. Sorry.

Q. What is a priori knowledge?

A. Sorry. A priori knowledge is knowledge you have about the factors of interest before you go into your analysis. So EPA came up with a nice list of potential confounders. That's what we in epidemiology would do. What are the factors we think could have an effect on the relationship that we are interested in?

We might graph those data, use tables to look at their frequency, and then apply statistical analyses to those tables. Unlike what EPA did in their contingency tables, we would examine all of the data and analyze it. And then if we have some evidence of potential confounding or we're concerned that a factor might be a potential confounder, we would do iterative regression modeling based on the type of data we have, whether it's logistic regression or negative binomial or multi-regression, whatever is appropriate, and examine how the confounders affect our risk estimates.

We use what we call post-regression diagnostics. We have

tests to see if our models are good. And we can test and compare different models to each other, even something called a likelihood ratio test. And that can tell us if a confounder is having a significant impact on the model.

So I would have done an extensive amount of analyses on these data before eliminating these factors as confounders.

Q. And, for instance, with habitat, you would not say there's something that needs to be looked at later but for now we're going to rule it out as a confounder.

A. If, for example, we had very limited data on habitat, let's say we have extensive missing data, which is not the case in the EPA dataset, we might say we couldn't control for it and we're going to examine that later with additional data collection and analysis. But we would not eliminate it as a confounder until we had done all of the analyses necessary to show it wasn't having an effect on our outcome. And then, you know, there's always room to do additional research, but I certainly would not have done what EPA did here.

Q. I'd like to turn your attention next to Joint Exhibit 58, page 464. It is page A-36 in the benchmark.

Mr. Tyree, can you put that on the screen?

This relates to the logistic regression that Dr. King and Mr. Becher talked about. Do you recall that?

A. I do recall that, yes.

Q. You talked about this somewhat earlier, but can you remind us what logistic regression is?

A. Sure. A logistic regression is used -- again, we have a binary outcome. So, for example, you could use it for examining predictors of the presence or absence of mayflies, for example, or a WVSCI score below 68 or above 68; so a binary outcome. And it can be multivariate. So you can include multiple variables in the model.

Q. Now, right below this highlighted statement about the conductivity levels of 300 and the chance of impairment, you're familiar with that statement? Dr. King talked about it before.

A. Yes.

Q. There's a graph. Do you see that?

A. Yes, I do.

Q. Does that graph have anything to do with logistic regression?

A. No. It actually has nothing to do with logistic regression.

Q. What is that?

A. If you look further up in the paragraph, so it's actually the first -- or, sorry -- the second complete sentence on the page, it starts with "Mean WVSCI scores," that sentence states, "Mean WVSCI scores from 60 bins were regressed with conductivity (see Figure A-9)."

So this figure is actually a plot of the mean WVSCI score for each of the bins of conductivity that they calculated. It's really nothing more than a visual representation of the mean WVSCI score across conductivity bins, but it has nothing to do with logistic regression.

Q. Does that graph have any predictive value?

A. No.

Q. Okay. Let's look at the highlighted statement. Mr. King -- Dr. King and Mr. Becher talked about that. It says, "Using logistic regression, the probability of impairment at 500 microsiemens is .72 and at 300 microsiemens is .59." Do you see that?

A. I do see that.

Q. How did they get these numbers?

A. I have no idea. They provide no information in any -- anywhere in the benchmark about what model they used for their logistic regression, what outcome, what method they used or variables in the model.

Quite frankly, when we use logistic regression, what we're interested in is, as I described yesterday, the beta coefficients in the model. Logistic regression provides us with an odds ratio, and that tells us -- it's a relative measure that tells us what the relative increase in risk for our outcome is compared to a lower value of our predictor.

So we can tell if conductivity goes up, what's the

relative increase in our probability of an impaired WVSCI score, for example, relative to lower conductivity. That's the -- that's what we use logistic regression for.

I don't know how you could use logistic regression to calculate these probabilities. If you look at a logit model, which is what that is, a logistic regression model, it may be possible to plug in some values and solve for the algebraic, but we would never use logistic regression in that fashion.

Q. Did you hear Dr. King testify yesterday during cross-examination that he did not have access to the model that EPA used to compute these numbers?

A. That's correct. I haven't seen any evidence that they provide details of what this model was.

Q. In any event, does this logistic regression statement tell us anything about the likelihood of impairment?

A. No, it certainly does not.

Q. Does it address confounding factors?

A. No. There's no information at all about their model, whether they controlled for confounding factors or how they calculated these probabilities using their logistic model. As far as I'm concerned, this sentence is completely meaningless. This provides us no information at all.

Q. Let's talk next about how Dr. King addresses confounding factors. You were present at his deposition, correct?

A. Yes, I was.

Q. And you were present during his testimony, correct?
A. Yes, I was.
Q. And you've read his expert reports, correct?
A. Yes, I have.
Q. He relies heavily on the analysis performed by EPA, doesn't he?
A. Yes, he does.
Q. But he also does his own analysis, correct?
A. That's correct.
Q. He did that after conceding in his deposition that there were some limitations in EPA's analysis, correct?
A. I believe that's correct, yes.
Q. Now, as I understand it, Dr. King did this -- and you tell me if I've misrepresented your exhibits, but he did this by exploring the link between conductivity --
A. Uh-huh.
Q. -- and temperature, correct?
A. That's correct.
Q. And he found a low correlation, correct?
A. I believe that's correct, yes.
Q. Okay. I think the correlation was -- the temperature and conductivity in the summer was .058. Does that sound right?
A. I think it was an R-squared, which is the square of the correlation that --
Q. Right. You're right.

A. But they're closely related. You just take the square root of that, and you would get the correlation coefficient, I believe.

Q. Okay. And then he also had that odd graph in Joint Exhibit 32 where he ran an R-squared analysis on mayfly taxa and temperature and came up with an R-squared value of .048, correct?

A. That's correct. So that would be a capital "R."

Q. My apologies.

A. That's okay.

Q. Okay. And that .048 as we discussed was similar to the .08 for smoking and lung cancer, for instance. So just for comparison purposes, I'm going to put that up beside, just to remind ourselves that those two are similar, correct?

A. Sure. Uh-huh.

Q. So he found low correlations between conductivity and temperature, and between temperature and impairment, and said this shows that temperature is not a confounder, essentially, correct?

A. Essentially that's what he did.

Q. You don't agree with that analysis, do you?

A. I do not agree with that analysis, no.

Q. Mr. Tyree, can we put up on the screen Joint Exhibit 29?

I pressed Laptop, Terry, and it didn't turn on.

(Mr. Harvey and the Clerk conferred privately off the

record.)

BY MR. HARVEY:

Q. And Joint Exhibit 29, is this the graph that Dr. King used to discuss the relationship between temperature and conductivity?

A. Yes, it is.

Q. What's wrong with that analysis?

A. Well, there are a number of things wrong with the analysis. First off, he limits his analysis to summer data only. It's not clear to me why he chose to do that. I think he believes that by truncating your data, whether it's by season or temperature, you're somehow removing confounding. This is absolutely not the case. So we have only part of the whole dataset here.

The other problem is that the data are not -- I'm sorry. I'm getting myself tied up in knots here.

The R-squared of his model actually indicates that the model he used, which is just a simple regression, does not actually fit this data very well at all.

He also ignores all of the evidence from the EPA's analyses that temperature and conductivity are related to each other.

Q. Let's talk about that briefly, and we've seen it before, but just so we're all on the same page, Joint Exhibit 58, page 414, contains the analysis that EPA did on the entire dataset,

correct?

A. That's correct.

Q. Okay. And what correlation did they find between temperature data and conductivity?

A. It was 0.4 based on this matrix here.

Q. Okay. And as we discussed earlier, there's a graph of that relationship, correct?

A. That's correct, yes.

Q. Okay. If you ran a regression not on the entire dataset but only on the summer data, would that tend to give you a lower R-squared number?

A. It's going to limit your ability to interpret your data. Based on the graphs that I have seen, temperature and conductivity both rise in the summertime by whatever mechanism that happens. And so they tend to flatten out, and so you may see less of this slope, if you will. But whenever you truncate your data, you're missing important information about the relationships between the variables in your data.

So the biggest problem we have here is that he feels that truncating his data -- when I say "truncate," it means eliminating data that's lower than a certain level or higher than a certain level.

That doesn't eliminate confounding of your relationship, and it can distort the relationship that you observe. So it's not good practice to do that unless you have a really good

methodological reason, and I don't see any reason to do that here at all.

Q. Would a competent statistician or epidemiologist eliminate temperature as confounding -- as a confounder based on the analysis that Dr. King performed with that graph?

A. No.

Q. Okay. We've talked about the relationship that Dr. King found between temperature and conductivity. R-squared .058, right?

A. Correct.

Q. And you found that that tells us nothing about whether temperature is a confounder, correct?

A. That's correct.

Q. He also analyzed the relationship between temperature and impairment, correct?

A. That's correct.

Q. Okay. And he did that in Joint Exhibit 32, I believe.

Mr. Tyree, can you put that on the screen?

What is Dr. King attempting to show in this graph?

A. I think he's attempting to show that temperature is not related to the number of taxa that were counted at these sites.

Q. Do you agree that he had the X and the Y axes mixed up? Do you accept that?

A. I thought it looked a little funny, yeah.

Q. Does this graph prove that temperature is not a confounder?

A. No. Again, he's truncated the data. So we're missing an enormous amount of data here, and that limits our ability to interpret it.

The other thing to remember is, we're interested in whether temperature is a risk factor for the outcome. And so we know, at least based on, again, a priori knowledge and scientific knowledge, that temperature is a risk factor for viability is how I would describe it, and so it meets that criteria.

This tells us almost nothing, not to mention the fact that he used the wrong kind of regression to calculate his R-squared if that's what he was doing.

Q. He should have used some form of regression that takes into account the fact that this is count data, correct?

A. That's correct.

Q. Something like Poisson regression that you discussed earlier?

A. Poisson regression or negative binomial regression, that's correct.

Q. But he testified he used a simple linear regression, correct?

A. That's correct.

Q. Is that partly why this graph is sort of a mess and --

A. Well, the line doesn't make much sense, and it -- yeah. The regression itself is pretty meaningless here.

Q. So when you talk about risk factors, it's like the discussion I had with Dr. King about smoking. The correlation for smoking and lung cancer is low by his testimony, somewhere around .08, correct?

A. Right. He describes the R-squared or the variance explained in -- by smoking as being .08.

Q. Okay. But even he admitted that he would not rule out smoking as a confounder because it's a risk factor, right?

A. That's correct.

Q. And the same is true of temperature, correct?

A. I think there is ample evidence that temperature is a potential confounder and should have been evaluated in the modeling process of the exposure here, conductivity, and the outcome of interest, which was impairment, yes.

Q. I'd like to turn again to *Rothman on Modern Epidemiology*, which is Defense Exhibit 21. And this is from page 132 of Defendant's Exhibit 21. And Rothman talks about criteria for a confounding factor. Do you see that?

A. That's correct.

Q. Tell the Court, if you would, what's important about this discussion in *Rothman*?

A. So what Rothman is doing here is he's providing details about the criteria necessary for a factor to be a confounder.

And in this particular highlighted paragraph, he's talking about the fact that a confounder must be an extraneous risk factor for the disease. And by "extraneous," we mean not in the path of causation of the exposure.

So what he said is, well, A, that it needs to be a risk factor for the disease. That's one of the criteria. But he also states that the data may serve as a guide to the relation between the potential confounder and the disease, but it is the actual relation between the potentially confounding factor and disease, not the apparent relation observed in the data, that determines whether it's confounding.

And this is a cautionary statement because if we have, again, a priori knowledge or concern that a factor may meet the criteria for confounding, we don't eliminate it simply because of something -- a statistic we might see in our data. We're going to evaluate it as a potential confounder in our modeling to make sure it is not having an effect on the relationship that we are analyzing.

Q. And you were present yesterday when Dr. King and I talked about that passage in the *American Journal of Epidemiology* from Johns Hopkins? Do you recall that?

A. That's correct, yes.

Q. And talked about R-squared coefficients or coefficients correlation being possibly misleading in terms of identifying confounding?

A. Absolutely. So, remember, correlation coefficients only tell us whether two variables move in the same or opposite directions and how close they are to a straight line. They just don't tell us anything about effect. It's not -- mathematically that's not what they're meant to do. And that's why you can find funny correlations like the rate of crime and the sale of popsicles in the summer. They are highly correlated, but they have nothing to do with each other.

So correlations can be spurious and they can be misleading, which is why we do not rely on them for causation and we do not rely on them to accept or eliminate or evaluate potential confounding.

Q. Would any competent epidemiologist or statistician eliminate a risk factor based on a low R-squared number?

A. No.

Q. Mr. Tyree, could you turn to Joint Exhibit 32, which is Dr. King's graph?

Did Dr. King in this graph also change the outcome of interest?

A. Well, again, my understanding from the EPA benchmark is they were interested in exposure to conductivity and impairment. And as I've described, if that is the relationship of interest, then that is the relationship for which we need to be evaluating potential confounders. To

evaluate confounding of that exposure on a completely different outcome, whether it's the number of taxa or the presence or absence of mayflies, is a completely separate analysis.

So this does not inform us as to whether or not there's confounding of the relationship between the exposure of conductivity and the outcome of impairment.

Q. Were the graphs prepared by Dr. King based on snapshot data?

A. Yes. All of EPA's -- or, sorry -- DEP's data is cross-sectional or snapshot data. They are individual measurements from a site at a particular time.

Q. And so Dr. King's graphs suffer from the limitations that he's identified with using snapshot data.

A. Absolutely. When we have cross-sectional data, we are limited in our analyses, particularly if we have snapshot data of measures that vary over time. Ideally you would want to have multiple measurements of those measures, and then we would use techniques to account for time series data, is what we would call that.

We don't have that here. So we have to recognize those limitations in the data and interpret our results accordingly.

Q. So that might give you even less confidence in using a figure or a statistic like R-squared.

A. Yeah. We just wouldn't use R-squared to tell us much of

anything. It doesn't tell us about statistical significance. It doesn't tell us about how the predictor impacts the outcome. We just don't use R-squared like that at all.

Q. I'd like to next turn to Joint Exhibit 25, which is another table that Dr. King prepared.

This is a table that Dr. King testified about on direct examination with Mr. Becher. Do you recall that?

A. I do.

Q. And he used this table to establish causation. Do you recall that?

A. Yes, I do.

Q. Do you think that you can use this table to establish causation between conductivity and failing WVSCI scores? That is, can this table be used to show that conductivity causes WVSCI scores to pass or fail?

A. No, you can't use a contingency table alone to establish causation. Contingency tables, which is what we would call this, are useful for visualizing the data, for getting a sense of the distribution of your data.

He's got bins of conductivity and pass/fail scores, and that can be very helpful for visualizing the data, but contingency tables can be misleading. There are statistics you can use to evaluate what you're seeing in a contingency table. There are many available, and -- but he doesn't do any of those.

We don't have a sense for whether these differences in pass/fail across conductivity scores are statistically significant, and there's no ability here to control for confounding.

You can stratify tables on a potential confounder. At some point, though, that becomes arduous, and so we would put this into a regression model; and, as we've discussed, with a binary outcome, we would use logistic regression.

Q. But you heard Dr. King say that he dropped out sites with, you know, marginal or poor habitat and low pH. He did some of that. Why doesn't that make this table accurate?

A. Again, simply removing certain values of a confounder does not control for confounding. All you are doing is possibly looking at the relationship for one strata of that confounder, so for one range of that confounder, but it doesn't control for confounding.

My concern would be that the confounder would vary across your exposure categories here, which would by definition render it uncontrolled confounding. And so that's not a method for doing that. It simply won't work. And, in fact, by eliminating additional data, you limit your ability to even assess the confounding effects of that potential confounder. So that does not help.

MR. HARVEY: And may I approach, Your Honor?

THE COURT: You may.

BY MR. HARVEY:

Q. And as we discussed yesterday with Dr. King, this table doesn't account at all, or even attempt to, for some confounders like temperature, correct?

A. That's correct.

Q. He didn't address that in any way, did he?

A. There's no what we would call stratification on confound -- excuse me -- on temperature, on habitat, or any of the other potential confounders. That's correct.

Q. So, for instance, in his table, he's got conductivity levels of 1001 to 1500. Do you see that?

A. I do.

Q. And he finds that you failed a WVSCI test 85 percent of the time, correct?

A. That is correct.

Q. Do we know what the temperature levels are in the fail column?

A. No.

Q. Do we know what they are in the pass column?

A. No.

Q. Is that important?

A. Yes, as is additional other information about those sites.

Q. Did you hear Dr. King talk about a paper by Greg Pond published in 2014?

A. Yes, I did.
Q. Mr. Tyree, can you pull up Plaintiffs' Exhibit 19?
Oh, you already have it. Go to page PE 296.
Can you see that okay, Miss Kuehn?
A. Yes, I can, depending on what we're looking at.
MR. HARVEY: May I approach, Your Honor?
THE COURT: Yes, you may.
THE WITNESS: Thank you.
BY MR. HARVEY:
Q. Greg Pond in this analysis found a high correlation between GLIMPSS, for instance, and conductivity, correct, .73?
A. Yes.
Q. But there are also other high correlations in this table, correct?
A. Yes, there are.
Q. For instance, percent forest land cover is .67, correct?
A. That's correct.
Q. Now, somehow Greg Pond was able to determine that even though we have these varying high correlations, that conductivity was the most important.
Did you get a chance to look at his paper?
A. I did look at this paper.
Q. How did he do that?
A. They used a method called principal components analysis to examine chemical factors and habitat factors, which is a

perfectly fine way to analyze these data. I think that was actually one of the recommendations from EPA. Interestingly, though, they only examined them separately. They did separate principal component analyses on chemical factors and on habitat, but they never put them together in the same model, at least as far as I could tell from reading the article.

Normally we would expect to at least see all of the factors analyzed together, and it may be appropriate to separate them out, but I saw no evidence that they tried to evaluate how those factors fell out, if you will, into their different components when analyzed together.

They then identified three different principal components in the paper. I believe they call these axes -- axis 1, 2, and 3, all of which had very high eigenvalues, which is how you determine whether your component is relevant I guess to your further analysis is how I would describe it.

But then they go on, and what you're supposed to do is take the parts of each component that are most relevant to that component, and the way -- it's a little hard to describe, but the way it works is certain things will sort of clump together is how I would describe it based on correlations and collinearity and some other statistical facts.

You then take those components and you use what we would call a super variable or a variable that represents that component, and you would put it into a model, and you would

use that as a predictor of your outcome. You would use it as a proxy for your exposure.

And what that allows you to do is it allows you to include a whole lot of factors in your regression model without running into problems of oversaturation. So many of these variables are related to each other, and you might run into a problem of what we call collinearity where they just are predicting the same thing, and that can really mess up your regression. So we use this as a way to kind of condense them down into one bundled exposure, if you will.

They then ran a couple of models using regression, but they only focused on the first component. They completely ignored principal components two and three for both habitat and chemical exposure. There doesn't appear to be any rationale for that, even though their eigenvalues were very high. And they never, as far as I can tell from the paper, ran a model that included both the principal components from the chemical components and the habitat.

So while their paper is interesting, they ultimately go back and simply say, "Well, conductivity was the most important thing, and therefore that's a predictor of our outcome."

They never, as far as I can tell, looked at the beta coefficients in their model and their statistical significance. They, again, rely on R-squares. And so while

it appears they attempted to do some sophisticated modeling and there's a lot of good potential there to learn something, they completely missed the boat on telling us what we wanted to know about that relationship.

Q. Can you use this paper to show that conductivity is a cause of impairment?

A. No.

MR. HARVEY: One moment, Your Honor.

THE COURT: Certainly.

MR. HARVEY: No further questions.

Thank you, Miss Kuehn.

THE WITNESS: Thank you.

THE COURT: All right. Cross-examination?

CROSS EXAMINATION

BY MR. LOVETT:

Q. Good morning, Miss Kuehn.

A. Good morning.

Q. Boy, given your opinion of the 2014 Pond paper that you just read, are you surprised the journal editors accepted it?

A. Yeah.

Q. There's pretty basic errors there that you're describing, right?

A. There are some pretty significant errors, yes.

Q. Have you ever heard of the journal that that appeared in?

A. I need to recall what journal it was.

Q. Why don't you go look and tell me if you've heard of it before.
A. I need a copy of the exhibit, if you don't mind.
Q. Okay. It's a journal called *Environmental Management*. Do you know that journal?
A. I'm not particularly familiar with it, but I've heard it mentioned here at trial.
Q. Okay. Now, do you have your CV before you?
A. Yes, I do.
Q. It says here you've testified before in a case, right?
A. I have.
Q. And is that the only case you've testified in?
A. That's correct.
Q. And when was that?
A. That was in January of this year.
Q. Okay. And what was the subject of your testimony?
A. I testified about the quality system regulations.
Q. And is that within your -- what was the gist of your testimony?
A. I was testifying about compliance with the quality system regulations with regard to an in vitro device medical device company.
Q. So it was a medical device case, and you were an expert.
A. Roughly, yes.
Q. And were you an expert for plaintiff or defendant?

A. I was an expert for plaintiff.
Q. And who was the plaintiff?
A. Sekisui Corporation.
Q. And what was the nature of the claim, if you know?
A. It was a breach of contract case.
Q. Okay. And why were you asked to testify?
A. I was asked to testify about the compliance of the defendants with regard to federal regulations.
Q. Okay. And what expertise did you bring to that testimony?
A. For the last few years I have been working extensively in medical device regulatory affairs.
MR. LOVETT: May I approach, Your Honor?
THE COURT: Yes, you may.
BY MR. LOVETT:
Q. Now, is this -- have you seen this before?
A. Yes.
Q. Is this the order issued by the judge in that case?
A. Yes, it is.
Q. It was a federal judge in the Southern District of New York, I believe.
A. Yes. Judge Scheindlin.
Q. And how long did you testify in that case? How long were you on the witness stand?
A. A few hours. I don't recall how long. It spanned a

couple of days.

Q. Could I turn your attention to page 16 of that order, please.

A. Okay.

Q. Do you see section 5?

A. Yes, I do.

Q. Have you read that before?

A. I believe I read it when the order came out, sure.

Q. Would you read what the judge said about your testimony in section 5, please, from page -- starting on page 16?

A. Sure. "Sekisui's regulatory affairs expert, Carrie Kuehn, testified that ADI was not in compliance with the QSRs during the relevant period. At the outset, I note that Kuehn has never conducted or even witnessed an FDA inspection or an ISO audit. Her training is limited to attending regulatory conferences and reading relevant guidance materials."

Did you want me to keep going?

Q. Yes, please.

A. "Nonetheless, Kuehn repeatedly testified that ADI's documents differed from what she would expect to see in an FDA-compliant company. The FDA expects each company to implement a QMS tailored to its size and risk-level. The QSRs provide a 'framework' for companies to develop their own internal procedures. While Kuehn might have implemented the QSRs differently than ADI, her opinion does not render ADI

non-compliant."
Q. Continue, please.
A. "Moreover, Kuehn's methodology is flawed. Her conclusions are based on a review of documents, at least one of which she misread. The documents were provided by Sekisui's counsel at least four years after the relevant time period. Although she interviewed four ADI employees, she failed to speak with key compliance managers, such as Leigh Ayers. Thus, I cannot credit Kuehn's opinions over the contemporaneous conclusions of the FDA inspectors, ISO auditors, and customer auditors that visited ADI, interviewed management, and reviewed key documentation."
Q. Thank you. You've not testified in a case since, until today, correct?
A. That's correct.
Q. Now, let's turn to your CV here. Starting with your education, you have a masters in public health and specialization in epidemiology; is that right?
A. That's correct.
Q. And that's from 2003?
A. That's correct.
Q. Now, would you tell me what epidemiology is, please?
A. Again, epidemiology is the study of the effect of exposures on outcomes in populations. We use statistics to conduct epidemiologic research.

Q. On human populations, right?
A. It can be used on human populations, non-human populations.
Q. Well, the University of Washington, that's where you went to school to get your masters, right?
A. That's correct.
Q. On its website it defines epidemiology as the study of the frequency, distribution, and deterrence of diseases in human populations.
Isn't that really the definition of epidemiology?
A. That's another way to state it, yes.
Q. And the Wikipedia, which I know isn't a legal reference, but it defines "epistemology" as the science that studies the patterns, causes, and effects of health and disease conditions in defined populations.
So is that another definition?
A. It would be "epidemiology," and --
Q. Yes.
A. -- there are many ways to state it, but sure.
Q. Well, epidemiology really deals with human populations, doesn't it?
A. Again, epidemiologic methods and statistics have been applied on many different kinds of data, including non-human data and other types of observational data.
Q. Yeah, but epidemiology itself is the study of human

populations. It may be applied elsewhere, but your masters is in the study of human populations, correct?

A. Yes.

Q. Okay. You don't have any training at all in the study of ecological conditions, do you?

A. No, I do not.

Q. Now, have you ever been asked to analyze any ecological statistical data?

A. I'm sorry. I'm not sure what you mean by "ecological statistical data."

Q. Ecological data.

A. So you're speaking of measurements of ecology matters such as the DEP data that we've been discussing?

Q. Any at all.

A. No, I have not.

Q. You've never performed any ecological data analysis, have you?

A. On the types of data that we're referring to in the DEP, no, I have not.

Q. On any kind.

A. I used environmental data for my thesis. So that is why I'm qualifying it to the type of data that we're discussing in the DEP.

Q. What kind of ecological data did you use in your thesis?

A. I used hazardous waste data from the Department of

Environmental Health in the State of Washington for exposure data for my thesis.

I've also looked at nitrate and nitrate water data for a childhood cancer study. And I think those are the two main ones. That's why.

Q. You were using those data to understand the impact on human populations, right?

A. That's correct.

Q. Now, you say you have some published papers, correct?

A. That's correct.

Q. How many are there?

A. I haven't counted them.

Q. I think we counted them in your deposition and came up with four. Do you remember that?

A. I think that was limited to a specific time period. So I have much more than four.

Q. Okay. Tell me -- let's go through your peer -- I'd like to know about your peer-reviewed publications.

A. Okay.

Q. Okay. Let's start --

A. Do you want me to count them real quick?

Q. Let's go through each of them. I'd like to understand what they're about.

A. Okay. The most recent -- so I'll go most recent.

Q. Yeah.

A. Does that sound good?
Q. Let's do that.
A. The most recent is a review article on the burden of Influenza B. We did a structured literature review and published that in the *American Journal of Public Health*.
Q. What is a structured literature review?
A. A structured literature review is a review where we had specific criteria for the types of data we were interested in in the published literature. We then evaluated that information, synthesized it, and published our findings.
Q. And you are the third author on that. What was your role in that paper? What did you do?
A. I did quite a bit of the review of the literature that we looked at --
Q. Okay.
A. -- and did quite a bit of the writing, as well as the analysis and synthesis. We worked as a team.
Q. Did you do statistical analysis for that?
A. Not on this particular paper, no.
Q. What's the next published paper?
A. "Water quality monitoring records for estimating tap water arsenic and nitrate: a validation study."
Q. Okay. And that was published in 2010?
A. Correct.
Q. You are the third author on that article. What was your

role in that article?

A. So for this study, I was the study manager. So I did all of the data collection, data organization, and analyses.

This particular paper was more of a methods paper, if I recall. It's been a while since I looked at it, but essentially we were using tap water measurements and validating their utility compared to publicly available water data with regard to arsenic and nitrate levels. So we were publishing the methods in this particular paper.

Q. Did you perform any statistical operations for that paper?

A. I think Susan did most of the statistics for this particular paper.

Q. Okay. Thank you. What's the next one?

A. The next one is "An evaluation of semi-quantitative test strips for the measurement of nitrate in drinking water in epidemiologic studies."

Q. I'm sorry. Where's that on the -- who's the first author on that one?

A. That's Searles Nielsen S. That's the third one down.

Q. Okay.

A. And similar to the one above it, we -- it's publishing about the nitrate water study.

Q. And that was in 2008.

A. That's correct.

Q. And, again, you performed no data analysis for that paper, correct?
A. You know what, it's been a while. I honestly don't recall on this particular paper what we -- who did what.
Q. Okay. And what was the other -- what are the other published -- peer-reviewed published papers that you have?
A. The next one is "Measuring participation in multiple sclerosis: A comparison of the domains of frequency, importance, and self-efficacy."
Q. Again, that's 2008?
A. That's correct.
Q. And what was that paper about?
A. This was work that I did as part of the Multiple Sclerosis Rehabilitation, Research, and Training Center at U-dub. And so we had done an extensive observational survey study of patients with multiple sclerosis.

This paper was looking at patient-reported outcomes, essentially, is the point.

Q. Did you perform data analysis for that paper?
A. Yes, I did. I was one of the statisticians at the MSRRTC.
Q. Tell me what method you employed.
A. I would need to look at my notes. I honestly don't remember.
Q. Okay. And that was published in what journal?

A. That was published in -- I think that's *Disability and Rehabilitation*.
Q. And that's a peer-reviewed journal?
A. Yes.
Q. Okay. And what other published articles, peer-reviewed published articles do you have?
A. "Antidepressant use in multiple sclerosis: Epidemiologic study of a large community sample."
Q. Okay. And that's in which journal?
A. *Multiple Sclerosis*.
Q. And that's peer-reviewed in 2007, correct?
A. That's correct.
Q. And you're the third author on that paper, right?
A. That's correct.
Q. And what was your role?
A. I'm the fourth author on that paper. Sorry.
Q. Oh, I'm sorry.
A. That's all right.
Q. And what is your role in that paper?
A. Again, I was one of the statisticians with the MSRRTC. So I handled a lot of data. I did some of the writing, some of the analyses.
Q. Do you remember any of the statistical methods you used in that paper?
A. Like I said, it's been a while. I would need to go back

and use -- I would've used any of the statistical methods that I've discussed here today and am familiar with.

Q. But as you sit here, you don't remember which ones they were.

A. I would need to look at my notes.

Q. Okay. Any other published, peer-reviewed articles?

A. Yes.

Q. Okay.

A. The next one is "Symptom burden in persons with spinal cord injury."

Q. Okay. And that was published in 2007?

A. Correct.

Q. And you're the second author on that article?

A. That's correct.

Q. And that dealt with human subjects, I guess?

A. Yeah. Again, this is all coming out of the rehab medicine group that I worked with.

Q. And what was your role in that paper?

A. Again, I was a statistician.

Q. Okay. And what other published articles do you have?

A. "Assistive technology use among adolescents and young adults with spina bifida."

Q. Uh-huh.

A. The *American Journal of Public Health*.

Q. 2007?

A. That's correct.
Q. What was your role in that paper?
A. Similar to the others. I was a statistician in the MSRRTC.
Q. Okay. And other published articles?
A. The next one is "Risk of malformations associated with residential proximity to hazardous waste sites in Washington State."
Q. And that's published in where?
A. *Environmental Research*.
Q. A peer-reviewed journal?
A. Yes.
Q. Okay. What was your role in that paper?
A. I was the lead author, statistician, and study design. This was my thesis work.
Q. This is your thesis work?
A. That's correct.
Q. Any other peer-reviewed publications?
A. Yes.
Q. And these would've all been while you were in graduate school or before then if that was your thesis work? Is that a fair assessment or not?
A. Well, they were published after I graduated, but -- and some of that analyses and work continued after graduation --
Q. Okay.

A. -- but some of this work was done while I was a graduate student.
Q. Well, how many other peer-reviewed -- I don't want to spend all day here, so --
A. Three, four, five, six, seven, eight. I have another eight peer-reviewed published articles.
Q. Okay. And they all deal with human subjects, right?
A. I think that's an accurate statement.
Q. Okay. Now, that section of your CV that's labeled Academic Credentials and Professional Honors, now you don't have any honors listed there, but I think you mentioned to Mr. Harvey yesterday a couple of honors. Is that true?
A. No. What I mentioned were professional affiliations, which can be found on the second to last page of my CV.
Q. Do you have any professional honors?
A. I'm not sure. So I think what that would mean is like an honorary degree or something like that. And, no, I do not.
Q. Any award, any recognition that you've had for your professional activities?
A. Oh, yes. I've had a number of awards.
Q. Okay.
A. I don't think that they are included on here, but, yes, I've had awards.
Q. Tell us your --
A. I received an award for my work on my thesis when it was

presented.
Q. And when was that award --
A. I need to look. I would need to look back. I honestly don't recall.
Q. Anything more recent than that?
A. No.
Q. Now, in your testimony with Mr. Harvey, I believe you said you had taken 10 classes in statistics; is that right?
A. At least.
Q. But in your deposition, I think you only listed four classes in statistics. Does that sound familiar to you?
A. It may have been in relation to the question that was asked, but I can verify with my university transcripts that I took a lot more than four.
Q. Okay. Well, let's figure that out, because in your deposition you said you took Statistics 101, right?
A. As an undergraduate.
Q. As an undergraduate.
A. Uh-huh.
Q. And then you took biostatistics for three quarters. Is that as an undergraduate as well?
A. No. Those were graduate-level biostatistics classes.
Q. Did you take any other undergraduate statistics courses besides Statistics 101?
A. Undergraduate?

Q. Yes.
A. No.
Q. Okay. And then you went to graduate school.
A. That's correct.
Q. And you took biostatistics.
A. I took three quarters of the required biostatistics that is necessary for the degrees that I achieved. I took three --
Q. Let me ask you, do you know what grade you got in that class?
A. Well, my graduating GPA was a 3.72. So I did pretty well.
Q. I mean do you remember that class in particular and how well --
A. I don't know what grade I got in that particular class.
Q. I wouldn't either.
A. I had two degrees. I worked two jobs through school, so --
Q. I wouldn't remember either. I just asked on the offhand --
A. Yeah. I have no idea.
Q. Okay. What other statistics classes did you take during your graduate work?
A. I took three epidemiology methods classes, which are all -- involve statistics. I also took an applied epidemiology course that required the application of the

statistical methods that we were being trained in in a 10-week course on a large observational dataset. And then I took two advanced biostatistics courses in logistic regression and survival analysis. And those are the ones I remember.

Q. Okay. Have you -- were those statistics classes related to epidemiology?

A. They were related to the statistical methods. So they were in the biostatistics department, but they were for my epidemiology degree.

Q. Statistical methods that epidemiologists use, right?

A. Biostatistics are used by many more fields than epidemiology.

Q. I understand your biostatistics course, but the later ones, the ones you mentioned after the biostatistics, the applied --

A. The four epidemiology courses I took were -- and they included statistics, were epidemiology-specific.

Q. Okay.

A. They included the basic of the methods I then went on to take advanced biostatistics classes in. And those are methods that are applied in epidemiology and across other fields of study.

Q. Have you ever taught a statistics class?

A. I was a TA for one of the applied epidemiology classes, and I taught or counseled students on the appropriate

programming and use of statistics for their projects.
Q. Okay. So you taught -- you were a TA when you were a graduate student.
A. Yeah.
Q. Okay. How many semesters were you a TA? Was it epidemiological statistics you were a TA --
A. It was the applied methods class, and I believe I TA'd that class one quarter.
Q. Have you ever taken a course on ecology?
A. I don't think specifically, no.
Q. Okay.
A. I'm trying to think back to my undergraduate, and I don't recall.
Q. And you've never taken a course on ecological data analysis, have you?
A. I've taken -- well, I'm not sure that there are courses offered in that, but I've taken courses on environmental epidemiology, which is -- my thesis was related to environmental exposures. So to that extent, I have taken coursework in environmental exposure.
Q. Those are exposures by human beings, right?
A. Exposures to human beings.
Q. To human beings. Okay.
You have no training in epidemiology outside the human context, do you?

A. In terms of the outcomes that I've been examining as an epidemiologist?
Q. In terms of data analysis.
A. As I mentioned, I have worked with environmental data.
Q. Related to human subjects.
A. As related to human outcomes, yes.
Q. And you don't claim to be an expert on ecology or biology or chemistry, do you?
A. No.
Q. Okay. Have you ever visited a stream in Appalachia?
A. No, I haven't.
Q. And you don't really know what the WVSCI method is, do you?
A. My understanding is that it is an index measure of ecological health of these streams.
Q. Do you know any more about it than that?
A. No.
Q. Okay. In your deposition you weren't sure, I think, whether it dealt with habitat or whether habitat was included within the WVSCI or GLIMPSS.

Do you know today whether habitat is part of the WVSCI or GLIMPSS method?
A. I am not very familiar with all of the components of it. What I understand is that WVSCI is a measure of health in that particular ecological system and that it is made up of a

number of components. It's an index.
Q. Okay. How long have you worked for Exponent?
A. It will be six years in October.
Q. And how many times have you been used as an expert in litigation?
A. As a testifying expert, this is my second time.
Q. Never testified in a deposition before except for the medical device case that we talked about earlier?
A. I was deposed in a personal matter back in --
Q. Oh, no. I don't care about that.
A. Yeah. But, no. Other than that, no.
Q. Okay. And were you hired as an expert in other litigation that you ended up -- you didn't end up testifying in?
A. Not as a testifying expert.
Q. Okay. Okay. As an expert in any other capacity?
A. My work on any other litigation is strictly confidential. I'm not going to testify about that.
Q. I'm not asking you to tell me which cases you've worked on, just if you have and about how many of them.
THE WITNESS: Your Honor --
THE COURT: You can answer that.
THE WITNESS: Okay. I just want to make sure I'm not -- okay.
BY MR. LOVETT:

Q. I'm not going to ask you which companies.
A. Okay. I have been hired as a consulting expert.
Q. More than five times?
A. Sure. Yes.
Q. Okay. Now, I think you said early on in your testimony that you believe that it is appropriate -- and you do it all the time, I think -- to use observational data to show causation; is that right?
A. It is appropriate to use observational data in studies of the effect of an exposure on an outcome which can be -- the results of which can be used along with other evidence to establish causation.
Q. Well, okay. Let me ask you, do you think that the use of observational data alone is sufficient to establish causation?
A. It completely depends on the exposure and the outcome of interest.
Q. So is that sometimes?
A. Potentially.
Q. Well, do you know -- can you name -- can you tell me a case where you think it is appropriate to use observational data to establish causation?
A. Not off the top of my head, no.
Q. Not one?
A. No. I mean there's an infinite number of potential exposures and outcomes that we could discuss here, and I'm not

going to speculate as to which of them could be established solely with the use of observational data.

Q. I'd just like you to give me an example --

A. I don't have one.

Q. -- of cause --

A. I don't have one.

Q. Okay. In your deposition, on page 76 Mr. Becher asked you, "So you said that observation, you would not place too much weight on it. Do you think an appropriate analysis of causation and elimination of confounding factors can be solely done with observational data, or is that" -- and you said, "No, I would not."

Mr. Becher says, "Okay." You say, "I would not say that."

Mr. Becher says, "You would not say that?" And you say, "I would not say that you can establish causation solely with observational data."

A. That's correct.

Q. Do you agree with that statement still?

A. I still agree with that statement.

Q. Didn't you just tell me that in some cases, it was appropriate and in others not?

A. I told you that there's the potential that there could be something out there, but I can't possibly -- I can't give you an example. I don't think that contradicts my prior

statement.
Q. Okay. So theoretically you haven't ruled it out as logically impossible, but you can't think of any cases where it would be appropriate; and in your deposition, you said it was not appropriate.
Is that a fair assessment of your view?
A. I believe that's a fair statement, yes.
Q. Now, observational data are usually, I think, juxtapose with experimental or lab data. Is that a fair assessment or not?
A. I think that's right. There's different sources of evidence.
Q. And I think you said in your deposition that you'd like to see lab data on this, right?
A. If that was feasible, sure.
MR. LOVETT: May I approach?
THE COURT: You may.
BY MR. LOVETT:
Q. Have you seen this before?
A. No, I have not.
Q. Okay. Let me sort of take you through it.
A. Okay.
Q. This is a response the plaintiffs received from defendants, from your client here.
A. Okay.

Q. And we asked Fola for any lab data that it had.
A. Okay.
Q. And it responds to us -- you see our request? Documents related to any monitoring, measurement, sampling, analysis, or whole effluent toxicity testing.
Do you know what whole effluent toxicity testing is?
A. No, I don't.
Q. Okay. And then if you'd turn to page 3 --
A. Okay.
Q. -- you see we got a privilege log from them.
A. I'm sorry? We get what?
Q. A privilege log. It says Supplemental Privilege Log at the top.
A. Oh, I see it, yes.
Q. Do you see that?
A. Uh-huh.
Q. And the document that it's withholding is an analytical report, and it's called the whole effluent toxicity tests.
A. Okay.
Q. So do you know -- have you been told by anyone at Fola, your lawyers or anyone else, whether or not there is a whole effluent toxicity test or any kind of lab test taken in this case?
A. I have no idea.
Q. Never been mentioned to you?

A. No.
Q. Would you like to know if there is a lab test showing that the water was not toxic in a lab?
A. I don't know that it would have a whole lot of meaning for me, given I'm not qualified to interpret those kinds of information. So --
Q. Well, if somebody who were qualified told you that the toxicity tests came out positive and it didn't kill the organism, wouldn't that be the kind of thing that you would like to know to form an opinion about whether or not the water at issue is toxic?
A. I'm not forming opinions about whether or not the water was toxic. I'm forming opinions about the methods used to analyze observational data.
Q. Okay. Now, your criticism in this case, as I recall from your testimony, was limited to criticism of the benchmark and of the 2014 Pond paper; is that right?
A. I believe I was also providing criticism of Dr. King's work.
Q. Dr. King's testimony.
A. Correct, his expert report. That's correct.
Q. Right. But in terms of the literature, that was your testimony, right?
A. I believe that's all I've testified to with regard to the published literature, yes.

Q. Okay. So at tab 1 -- if you'd like our notebook, I'll --

A. I just need to know which --

Q. Plaintiffs' exhibits.

May I approach, Your Honor?

THE COURT: Yes, you may.

THE WITNESS: Okay.

THE COURT: Help her find the right notebook.

THE WITNESS: This one? Okay. I'm sorry. Which tab?

BY MR. LOVETT:

Q. 1.

A. Okay.

Q. Okay. So that is a paper by Bernhardt and Palmer.

A. I see that.

Q. You have no opinion about that paper, correct?

A. I would need to look it over. Did you want me to offer an opinion?

Q. No. You haven't offered any testimony or opinion about that paper, have you?

A. I haven't today. No, I have not.

Q. Okay. Tab 2, "How Many Mountains."

A. Yes.

Q. You've offered no opinion or testimony about that, correct?

A. I have not today, no.
Q. Okay. Tab 3, "Derivation of a benchmark for freshwater ionic strength." No opinion, correct?
A. To the extent that this is related to the benchmark work, I think my opinions may extend, but I have not testified about this particular article today.
Q. Okay. Same is true for tab 4, "A method for assessing causal field exposure response relationships," right?
A. Similar to the answer I just gave. To the extent that this report is similar methodology as the benchmark, my criticisms would extend to that.
Q. For instance, with "How Many Mountains," you don't have any statistical -- you haven't provided any criticism of the statistical methods adopted in that, have you?
A. I have not been asked to today.
Q. Okay. I won't take you through all the tabs, but it's fair to say that's going to be true of the other tabs here, right?
A. I have not answered any questions regarding these other articles. I'd be happy to if you would like to ask me some.
Q. No. Thank you.
A. All right.
Q. Now, statistics are pretty confusing to laypeople like me. So I apologize for my lack of familiarity with the terminology. I'm sure I will get it wrong.

A. Okay.
Q. So bear with me, please. Let me just start, this is a complicated statistical question, isn't it? A lot of work has been done here.
A. The question of the exposure and outcome that is being evaluated here?
Q. Yes.
A. It is a complex question.
Q. And there are over 20 published papers on this issue, right?
A. I don't know that personally.
Q. Well, you sat through it and heard -- you sat through both Dr. Palmer's testimony and Dr. King's, didn't you?
A. My understanding is that there were about 20 papers that she had relied on or that contained information. So to the extent that that's true, then yes.
Q. So -- and then you testify basically in polar opposition to Dr. King, right?
A. I would say that's accurate.
Q. You disagree with almost everything he's done.
A. With regard to this data, yes.
Q. And the same is true of EPA and the benchmark. You disagree with almost everything that they did and the EPA did.
A. I disagree with the epidemiologic and statistical methods they applied to these data; yes, I do.

Q. And that's the heart of the benchmark, isn't it?
A. I believe -- well, yeah, I believe that's true.
Q. So how do we decide who to believe? I mean on the one hand, we've got you saying everything that Dr. King, the benchmark, have done is wrong; and you have a bunch of reasons and they have a bunch of reasons. How do we decide who to believe?
A. I can give you a stack of textbooks that will contradict everything that they did and support everything that I've testified to.
Q. Well, there's another way, isn't there? It's called peer-review. Have any of the opinions you expressed here today been peer-reviewed or published in any journal?
A. Not yet.
Q. Okay. Do you know who the lead author -- who the statistician on the benchmark was?
A. I don't know.
Q. Do you know what his qualifications were?
A. If it's the gentleman that Dr. King talked about yesterday, it sounds like he's an expert in environmental toxicology.
Q. I think his name is Yuan; is that right?
A. If that's his name, sure.
Q. You're not familiar with him at all, are you?
A. I am not.

Q. You don't -- can you name any environmental data analyst except for Dr. King?
A. I'm sorry. Say that again.
Q. Can you name a single environmental data analyst except for Dr. King?
A. No. He's the only person I know that claims to be an ecological data analyst.
Q. Did you ask any other epidemiologist to review the materials that you testified about here today?
A. Yes, I did.
Q. Okay. Who was that?
A. Some colleagues of mine, epidemiologist who works with me at Exponent.
Q. Okay. Did somebody help you with forming your opinions, then?
A. No. She -- she helped me with organizing materials and whatnot. I formed my own opinions.
Q. And what was her training?
A. She has a Ph.D. in epidemiology.
Q. Okay. And what's her name?
A. Vanessa Perez.
Q. Now, those 20 papers have all been peer-reviewed, is that your understanding, approximately?
A. Well, they were reviewed by peers in the same field.
Q. Yes, they were. Right. And you heard testimony I think

that there were statisticians. Many of them were authored by statisticians and reviewed by statisticians. Is that true?

A. I don't recall hearing that testimony, no.

Q. Okay. Let me turn to the benchmark, which is Joint Exhibit 58, and that's one of the books -- it should say Joint Exhibit Book 1, I think.

A. I hope this is the right one.

Q. It says 1 to 58.

A. This says 58 Appendix E-81.

Q. It should have tabs on it.

A. Not that one. Hang on.

MR. LOVETT: May I approach, Your Honor?

THE COURT: Yes. Help locate the right notebook.

BY MR. LOVETT:

Q. This is it.

A. Okay. I just want to make sure I'm looking at the right thing. Okay. I'm sorry. Which one am I looking for?

Q. The last tab. It's the benchmark.

A. Okay.

Q. Now, you testified extensively about that here today, didn't you?

A. Yes, I did.

Q. Okay. Do you know the procedure for how this benchmark gets approved?

A. No, I don't.

Q. Okay. Let's look at the authors of the benchmark. That's on JE 376.
A. Okay.
Q. There are a lot of Ph.D.'s on there, right?
A. Yes.
Q. Do you know any of them?
A. Personally, no.
Q. Have you ever heard of any of them?
A. I've heard of Cormier and Suter.
Q. Okay. And you've heard of them because they --
A. And Pond.
Q. Okay. Because of the testimony in this case, right?
A. The articles I've reviewed for the case, etcetera, sure.
Q. Anybody else?
A. No.
Q. Do you know if any of them are statisticians?
A. I don't.
Q. And then you testified about the -- well, do you understand that EPA has a Scientific Advisory Board that reviews the benchmark to see if it passes scientific muster?
A. So this is my understanding, is that the authors authored the benchmark. It went to a review panel of some kind. They received comments. The EPA received comments. And they responded to those comments in the final benchmark.
As far as I can tell, it did not go through another round

of review to see if those comments had been adequately addressed.

Q. Okay. But the testimony is that there is a -- and I think the -- the benchmark is submitted to the SAB.

A. Okay.

Q. The SAB appoints a committee that reviews the benchmark, right?

A. Uh-huh.

Q. That's the report that we have.

A. Okay.

Q. And then that either -- we're not sure about this, but either that report or that report and the benchmark go to the full SAB for review, right?

A. My understanding was it was the report, not the full benchmark. But, again, it sounds like there's some question there. So I don't know the answer any better than you do.

Q. Okay. But in any event, at least the full SAB looked at the report about the benchmark.

A. Yes, I believe that's true.

Q. And you testified in your deposition that there were no epidemiologists on the SAB. Do you remember that?

A. I did not identify any epidemiologists.

Q. Did you look at the SAB report before you gave that answer? Excuse me. The SAB report.

A. The comments?

Q. Yes.
A. No, I did not.
Q. Let's do that.
A. Actually -- I'm sorry. May I correct that statement? I believe that the benchmark lists the reviewers --
Q. Uh-huh.
A. -- of the report and the SAB. So I did look for information on all of those people. So, yes.
Q. Let's do an easy thing and turn to page 376.
A. Okay.
Q. PE 376. This is the Scientific Advisory Board.
A. 376 looks like it's the authors and the contributors. Am I not looking at the right thing?
Q. I think it says U. S. EPA Science Advisory Board. Do you see that? PE 376. Page 376.
A. PE? I'm sorry. I'm looking at JE.
Q. I'm sorry.
A. That's okay. I'm confused.

I'm sorry, Your Honor, but I need a break here.

THE COURT: All right. Why don't we take a ten-minute recess.

THE WITNESS: Thank you.

THE COURT: You can step down. Don't discuss your testimony.

THE WITNESS: Yeah.

(Recess from 10:43 a.m. to 10:53 a.m.)

BY MR. LOVETT:

Q. So that is a list of the Scientific Advisory Board I think. Do you agree with that?

A. Yes, this is the list.

Q. Science Advisory Board. I've been calling it the wrong thing.

And do you see that one of the reviewers is named Dr. Patricia Buffler?

A. Patricia Buffler, yes.

Q. Have you heard of her?

A. Yes, I have.

Q. Is she an eminent epidemiologist?

A. Yes. She's a well-known epidemiologist.

Q. And she was dean of the department of epidemiology at the University of California-Berkeley, right?

A. She was the dean emeritus, yes.

Q. So she reviewed at least the committee report, didn't she?

A. Well, she would have at least reviewed the --

MR. HARVEY: Objection; lack of foundation.

THE WITNESS: I don't know what she reviewed, but assuming she reviewed at least the committee report, she would have been aware of the criticisms that we've discussed regarding the use of statistics.

BY MR. LOVETT:

Q. Okay. Let's turn to page 402 where I think you've testified about a bullet point that's towards the top of that page.

A. Yes.

Q. So this is from the Scientific Advisory Board and a recommendation to the authors of the benchmark, correct?

A. That's correct.

Q. And it says, "Consider further use of quantitative statistical analysis for understanding causality and the potential role of confounding factors."

A. Yes.

Q. That's right what you pointed to, isn't it?

A. That's correct.

Q. It says -- and the reason it says is because parametric procedures have been used successfully elsewhere to evaluate multivariate environmental datasets and can provide a relatively objective quantitative framework for data analysis. A more rigorous statistical analysis should be contained in the document, right?

A. Right. So they're stating that because these methods have been used elsewhere to evaluate this type of data, that the EPA should apply a more rigorous statistical approach.

Q. And, "Further, it would be helpful for the authors to clarify whether nonparametric multivariate methods, such as

non-metric multidimensional scaling were considered."
A. That's correct.
Q. "And at a minimum, the EPA document should discuss the pros and cons of multivariate statistical methods and explain why these approaches were not applied," right?
A. That's right.
Q. So EPA did do that, didn't it?
A. No, they did not. They provided a nonsensical response to the comments, and they did not discuss at all the rationale for why other approaches had not been applied to these data.
Q. I understand you think it's nonsensical, but you don't think it tried to explain why what it did in response to this comment?
A. I'm not saying they didn't try to explain it. I'm saying their explanation made no sense.
Q. You disagree with their explanation because you don't understand it, right?
A. No. I disagree with their explanation because it's nonsensical and it doesn't answer the questions.
Q. Okay. What is -- let me ask you, what is non-metric multidimensional scaling?
A. It's going to be a nonparametric method of evaluating the data. It is not a statistical method that I have used.
Q. Do you know what it is? Can you give a good explanation of how it works?

A. No. I would need to look it up. That's not a method I'm particularly familiar with.

Q. So maybe that's why you think -- strike that.

Is that maybe why you don't understand EPA's response to this comment, because you don't understand the comment itself?

A. I understand EPA's response to the comment, and nowhere in the benchmark do they mention at all the application of any nonparametric multivariate methods, including non-metric multidimensional scaling.

Q. What data do you think EPA should have had -- used for the multi -- for the non-metric multidimensional scaling?

A. The data they had available to them.

Q. Which -- which were what?

A. Say again?

Q. Which -- okay. What should've used those data for?

A. They had a large observational dataset, and the advisory board is recommending that they apply various statistical methods to analyzing that data. So I'm not sure your question makes sense.

Q. Okay. I'll try to ask it as clearly as I can. Exactly what data should EPA have used to perform this analysis?

A. I just told you I am not familiar with this particular nonparametric analysis; but at a minimum, they would have needed to have examined their exposure and their outcome of interest and whenever their data were appropriate for

completing that model.

Q. And you can't tell me how EPA should have performed that analysis, correct?

A. This particular statistical method --

Q. Uh-huh.

A. -- no.

Q. Okay.

A. I would need to look it up.

Q. Thank you. And you haven't looked it up.

A. Not this particular one, no. There's a number of other ones that were suggested.

Q. Okay. Now, let's turn to page 383, if you would, too, please.

A. I'm sorry. Which page?

Q. 383. PE 383. Are you there?

A. I have seen that. Yes.

Q. Do you see the section that says Causality between Extirpation and Conductivity?

A. I do.

Q. In the benchmark, the SAB, which includes Professor Buffler, I believe, says, doesn't it, that the EPA document presents -- let me start before that.

"Building a strong case for causality between conductivity and loss of genera requires that two linkages be demonstrated: a strong relationship between stream

conductivity and the amount of MTM-VF in the upstream catchment, and a strong relationship between elevated stream conductivity and the loss of benthic macroinvertebrate taxa. The EPA document presents a convincing case for both linkages."

Do you see that?

A. I do see that.

Q. And that's why the Scientific Advisory Board approved the benchmark, isn't it?

A. I don't know that they actually approved the benchmark. My understanding is they provided comments to EPA about the benchmark. EPA made some revisions to the benchmark. And I don't believe the SAB ever saw it again prior to its publication.

Q. Okay. That's your understanding of the process?

A. That's my understanding. If I'm incorrect, I'll --

Q. Okay. Now, let's look at these members of the SAB. Do you recognize any of them except for Professor Buffler?

A. I'm sorry. Please remind me what page that's on.

Q. I believe it was 376.

A. So as I said, I recognize Dr. Buffler. Elaine Faustman looks familiar, but --

Q. Okay.

A. -- I couldn't tell you. I may have come across her work in the literature. That's it.

Q. Okay. So you don't know any of the authors of the benchmark, right?
A. That's correct.
Q. You're not familiar with their work.
A. Not inasmuch as it is outside the realm of what we've been talking about here, no.
Q. What about the Panel on Ecological Impacts -- it's on page 374 -- who reviewed the benchmark and provided the comments? Do you recognize any of them?
A. No.
Q. I think every one of them has "Doctor" before his or her name, right?
A. Yes.
Q. I think the same is true of the SAB.
A. That's possible.
Q. And I'm sure the same is true of everybody that reviewed every one of those journal articles, right?
A. Not necessarily. I've reviewed a number of journal articles and I don't have a "Doctor" in front of my name.
Q. Is it your understanding that the benchmark was derived to show the level at which conductivity causes impairment as measured by the WVSCI or the GLIMPSS?
A. Can you repeat that? I want to make sure I heard you correctly.
Q. Is it your understanding that the benchmark was derived

to show the level at which conductivity causes impairment as measured by an index like GLIMPSS or WVSCI?

A. I believe that that's the case. I'd need to look at the front half of the benchmark to make sure the wording that you're using is correct.

Q. It's not in the benchmark. That's my --

A. Okay. So you mentioned -- what I'm having trouble with is the fact that you mentioned a specific level.

Q. Okay. Let me --

A. So that's why I'm not following you.

Q. Let me ask you a more open-ended question.

A. Okay.

Q. Can you tell me why the benchmark was derived?

A. My understanding is that they were examining the effect of conductivity on stream impairment as measured by the WVSCI and whatnot.

Q. Okay. And it's with that understanding that you apply your tools to the benchmark, right?

A. That's correct.

Q. Did you apply any statistical methods to any of the data available in this case?

A. I have not had an opportunity to analyze the data.

Q. When were you hired as an expert in this case?

A. I believe it was May of this year.

Q. May?

A. May or April. I don't recall precisely. I'm sorry.
Q. Well, your deposition was on June 11th.
A. Okay.
Q. Would that tell me about how long before your deposition you were hired?
A. Well, I had an expert report that was due prior to that. So I believe I was hired in April. The report was due in May. And I was deposed in June. I think that's the approximate time line.
Q. Would you know how to analyze the environmental data that we have in this case to determine if conductivity and its associated ions cause impairment?
A. Using the observational data that is available from the DEP, yes, I do.
Q. Do you know how to do that?
A. I can do that, yes.
Q. Tell me the steps, every one of them, that you would use to do that.
A. Every single one of them?
Q. I want to know how you do it.
A. I would get the data from the DEP.
Q. Okay.
A. I would -- well, let me back up. Prior to that, I would assemble a team to work on the analysis. This is not a simple thing. This is a complex analysis, and it would take a lot of

time.
Q. Who would you put on the team?
A. I would have an ecologist --
Q. Okay.
A. -- with expertise in the measurements that were being taken and the outcomes of interest to make sure that we were evaluating the appropriate exposure and the appropriate outcome and that we had identified all of the factors that we should evaluate for confounding and effect modification. I would do it the same way I would do any other epidemiologic study.
Q. Okay. So you say you would have an ecologist. Who else would you have?
A. Maybe another epidemiologist to assist.
Q. Another epidemiologist?
A. Yeah.
Q. Okay. So you need two epidemiologists and one ecologist. What else?
A. That would be the basics of it.
Q. Okay. So a three-person team. Then what would you do -- let's see -- then request the data from whom?
A. Request the data from wherever it's located. I believe the Washington -- or, sorry -- the West Virginia DEP --
Q. Okay.
A. -- would provide the data.

Q. So you would gather the dataset. And how -- what tools would you apply to that dataset?
A. From my initial look at the data, I would simply open it up in Excel and take a look at it for a while, look at the values, look at how it's organized, look at the variables that were provided, and then I would convert that. When I'm ready to start exploring the data further, I would convert it into a STATA file, which STATA is assistance statistical software.
Q. Okay. STATA, is that a readily available statistical software program?
A. You can purchase it, yes. It's readily available for purchase.
Q. Right. It's, like, sort of Microsoft Word for your kind of statistics, right?
A. That's oversimplifying it, but, yeah, it's a statistical program that you can conduct any number of analyses.
Q. You don't know how to write statistical code, do you?
A. I write commands for STATA to perform the analyses. I'm not sure what you mean about writing statistical code, though.
Q. You don't know what that means?
A. Are you talking about writing actual code?
Q. Yes, writing actual code. Do you know how to do that?
A. So let's be clear. There is the code or the programs you have to write to run the analyses in the software. So STATA uses a particular set of commands, and you write those in a

do-file. STATA requires a specific set of commands, and you write that in a SAS file. So do I know how to do that? Yes. Am I a software programmer? No.

Q. I'm not asking if you're a software programmer. It's not the intent anyway. I want to know if you know how to use STATA -- and what was the other one?

A. SAS.

Q. STAT?

A. SAS. S-A-S.

Q. S-A-S?

A. Yes.

Q. And that's another off-the-shelf statistical software program, right?

A. Yes. Yes, it is.

Q. By the way, have you heard of TITAN before this?

A. Not before this, no.

Q. Did you examine the TITAN -- do you have the expertise to look at TITAN to understand whether or not it is a useful statistical tool?

A. TITAN does something that I'm not familiar with. So, no, that would not be my specific area of expertise.

Q. Okay. And also we've heard something about GAM models. Do you remember that?

A. Yes.

Q. What's a GAM model?

A. It's a generalized additive model. It's a type of regression.
Q. And do you know how to write a GAM model?
A. I could code for a GAM model, sure.
Q. You could?
A. Yes, I could.
Q. Tell me basically how you would do that, please.
A. You want me to tell you the STATA code for a GAM model?
Q. Yeah, I do.
A. I would need to look up the command, and then I can tell you what it is. So STATA has 12 volumes of command books, and I would need to look up the specific command, but it would include putting in the GAM command and specifying the exposure, the independent variables, the outcome, as well as any other special options for the model, the type of smoothing, the type of post-estimation that I wanted, and I would write that into a do-file and run it through my code.
Q. Basically you're telling me you would get out the instructions or the operating manual and read them and follow the instructions, correct?
A. No. There's a difference. So writing statistical code is not an exercise in memorization. You have to know what you're doing, and it is complex. There are many different options. So to make sure that your code works properly and provides you with the information that you need, there are

reference manuals, and every statistician that I know has to use them from time to time. So, yeah.

Q. Sure. And that's not my question. But you don't know how to do anything beyond using those already prepared programs, do you?

A. I'm not sure what you're talking about, beyond that. Beyond that is actual programming, writing computer code.

Q. And are undergraduates, advanced undergraduates in statistics now often taught to write their own code to develop programs to suit their particular purposes?

A. I don't know if that's true.

Q. All right. But in any event, your expertise, as I understand it, is limited to using STATA and SAS and applying those pre-prepared programs to data that come before you, right?

A. Yes, I would say that's true, me and thousands of other epidemiologists and statisticians who use those programs.

Q. Okay. So you get the data. You plug it into STATA and SAS. Which one would you use? STATA or SAS?

A. I would probably use STATA.

Q. Okay. STATA. Okay.

A. Uh-huh.

Q. And, you know, that's like "Appa-la-cha" or "Appa-lay-cha," I guess.

A. Right.

Q. What would you do in STATA with -- let me strike that. Let me start with a more basic level. Which of the data are you going to plug into STATA? What kind of data?

A. So let's be clear. A dataset is a series of rows and columns. It's essentially a giant spreadsheet, if you will, okay? You have records and you have variables. And so I would bring the entire dataset into STATA, and I would have access to all the variables, all of the records, which I believe there's over 2,000. I've worked in STATA where there were over 300,000 records before. So you can input -- you can bring in extremely large volumes of data, okay?

And then I have access to all of the variables that I might want to explore. One of the first things I do when I have a new dataset and I'm going to analyze a new question is I simply get a description of each variable, what does it look like, how is it coded, what are the minimum and maximum values. I'll look at the bottom few values and the top few values to see do I have anything that looks extreme or inappropriate; maybe there was a data entry error.

So I would look at basically the quality of the data, because my analysis from that point on will lack validity if my data has got problems. I'll look for missing data. What variables do I have extensive amounts of missing data in? Those I may not be able to use in my analysis as well, or it may require sub-analyses on just the portion for which I have

all the data.

So I would do extensive exploration basically getting to know my data.

Q. So can you tell me which data you would use, or is that something you would have to discover when you start working with it?

A. I would need to look at it. My understanding based on the benchmark is they've got a table with some of the variables that I --

Q. Since you haven't looked at the data, how do you know that you could use those data to show that conductivity either is or isn't causing impairment?

A. I don't know until I look at it.

Q. I thought you told me a minute ago that, sure, you could.

A. I said I could evaluate it for that cause, but I don't know if it can tell me -- give me good answers. It completely depends on what the data says, and I have not looked at it yet.

Q. So you don't know if the data is sufficient to reach the conclusion that EPA tried to reach or that -- strike that.

You don't know if the data is sufficient to answer the question that EPA asked, do you?

A. I have not looked at the data itself. Based on what I've seen and how it was described in the benchmark, I think it would be helpful for that purpose. I would certainly make an

attempt to examine it to see if I could conduct that analysis. And if I could, I would; and I would acknowledge the limitations, if there were any, in doing that analysis.

Q. One thing you certainly couldn't do is use nonparametric multivariate methods like non-multidimensional scaling, right?

A. I'm not saying I couldn't use it. I would need to look at what it is, how it should be used, what its limitations are, and if it's appropriate for the question at hand.

Q. I want to make sure I understand your testimony. You're not testifying, are you, that temperature or habitat are confounding factors? You're only testifying that Dr. King, the benchmark, and the 2014 Pond study did not eliminate those as confounding factors.

A. That is correct.

Q. You don't have any opinion about what's actually causing impairment, do you?

A. No, I do not.

Q. You testified about "a priore" knowledge.

A. "A priori."

Q. Okay. You say "to-may-to" and I say "to-mot-to."

A. It's Latin. I'm sorry.

Q. That's fine. Nobody knows how to pronounce Latin. They're all dead. That's the only thing I remember from Latin class.

A. That's all right.

Q. Anyway, "a priori," "a priore," whatever it is --
A. Okay.
Q. -- what is that in terms of statistical analysis?
A. When I say a priori, it just refers to our previous knowledge, knowledge we have that we bring to the analysis, knowledge that we are familiar with prior to conducting the study that we're doing.
Q. And for ecological data analysis, it's important to bring a priori knowledge in ecology, isn't it?
A. I would certainly say so, yes.
Q. And you heard Dr. Palmer's and Dr. King's testimony. Do you believe they have sufficient a priori knowledge in those fields to assess ecological problems?
A. Yes.
Q. What do you think of Dr. King's testimony generally, about him as a statistician? Is he just, like, incompetent? I mean I'm curious, because you have so fundamentally criticized him. Either he's incompetent or dishonest or uninformed, something.

What is it that you think is going on here?

A. I think he believes that what he is doing is correct. I think he has had some statistical training. I think it's limited. I think that he is applying methods he's not entirely familiar with and failing to recognize the limitations of those methods in how to appropriately evaluate

statistically the relationships that are of interest here.

So I just think there's -- he's missing some context and some training there.

Q. Do you think that Dr. King is not familiar with TITAN?

A. I don't -- he wrote TITAN. So I'm assuming he's familiar with it.

Q. I thought you said he wasn't familiar with the methods he was using.

A. The methods -- let me clarify, then. The methods with regard to the evaluation of conductivity as an exposure on the outcome of interest as we are discussing here as it relates to causation.

Q. Now, studying human beings is different from studying the natural world, isn't it?

A. Human beings are part of the natural world. They're dynamic systems. They have incredible variability, same as the natural world. I mean there's many similarities with regard to how we would examine these questions regardless of whether we're studying humans or cows or bugs or fish in a stream. They're dynamic systems. They can get sick. They can be affected by exposures. They can be affected by environment. So it's not much different.

Q. But you can't put natural environment into a lab very easily, can you?

A. No, you can't.

Q. That's the huge -- that's the big difference, right?
A. Well, depending on the question that you're asking, I believe that when you're dealing with, for example, non-human species, it is much more straightforward to design experiments such that you can evaluate those things. But, yeah, you can't put a stream in a lab.
Q. That's right. You can't put a stream in a lab. In epidemiology -- as an epidemiologist, you're used to dealing with things you can put in a lab, right?
A. No. Actually we're used to dealing with things you can't put in a lab. That's why we use observational data.
Q. You just -- you told me earlier that you couldn't use -- you couldn't think of a single example where you could use observational data to establish causation.
A. So you misunderstood my testimony about that.
Q. Okay. I'm sorry.
A. So we use observational data as one element for establishing a causal relationship, okay? There are other scientific disciplines involved with this. So, for example, if we look at smoking and cancer -- okay? -- there are geneticists who will evaluate the effect of nicotine on genes. As an epidemiologist, I'm not going to do that work. My work is in the realm of the observational data and the study methods that we use.
So when we're talking about using that and combining it

with other data for causation, I'm talking about evidence from other fields of study where they have done laboratory analyses, where they have broken down the contents of nicotine to show it has arsenic in it, etcetera. Epidemiologists are not going to necessarily do that type of work. There are some epidemiologists who work in labs; I'm not one of them.

Q. Okay. I understand that you don't work in a lab, but I asked you earlier if you could tell me a single example where causation had been established by observational data alone, and as I recall --

A. And as I said, I cannot think of a single one.

Q. Well, I don't understand your testimony. I'm not trying to be difficult. I just don't understand how that statement can be squared with the idea that you can use -- that you do it all the time, use observational data to establish causation.

A. I think you misunderstand that particular statement.

Q. Okay.

A. Epidemiologists rarely will establish causation based on observational research. Typically what you will find is that we will examine increased risks, we will look for associations, we will infer a relationship between an exposure and an outcome, but it requires a lot more than one or even two observational research studies to establish causation.

Q. Okay. So do you take action in the epidemiological world

to control drugs or devices where causation has not been established?

A. Again, I need you to clarify that question because I think you've completely shifted gears on me. So --

Q. Fine.

A. Okay.

Q. I'm not trying to. So I'm just trying to understand the world you're coming from, and I admit I don't understand it very well.

So you look at -- epidemiologists look at devices and drugs and public health issues, things like that, right, to decide how humans are impacted by those kinds of things?

A. I think that's a fair statement.

Q. Okay. And sometimes epidemiologists may recommend, for instance, to the FDA that it withdraw a drug or that it withdraw a medical device.

A. I --

Q. Is that wrong?

A. I think that that's a completely different situation. So let's start with the drug comment, okay?

Q. Okay.

A. So the whole field of pharmacoepidemiology is designed to examine drug exposure and health outcomes, whether they be positive or negative, okay? Excuse me. Whether or not the results from those studies provide recommendations to FDA,

that's entirely possible if it's found -- it may change the practice of medicine, but that's done in a consensus-based way. They may make recommendations, sure, if that's what you're talking about.

If you're talking about adverse events, then you're talking about something completely different.

Q. All I'm trying to establish is the level of confidence that one needs to take action to withdraw a drug, control a pollutant, all of those kinds of things.

In your field what level of confidence do you have to have before -- do you have to be sure that X causes Y before you make a recommendation to take action based on the relationship between the two?

A. So FDA has internal policies about whether or not a recall is necessary for a device or a drug, and that is not necessarily dependent on epidemiologic research, which is what I'm here talking about. They will look at trending. They will look at all kinds of different things.

I think you're misstating how epidemiology interacts with FDA. I don't see how that's relevant here either.

Q. Okay. You say you can establish causation through observational data, right?

A. I think I said the exact opposite of that. I said that it would require -- I think you've asked me multiple times to give you an example where observational research can establish

causation, and I told you I cannot give you one, of one piece of evidence that can be used to establish causation among a preponderance of additional evidence.

Q. Okay. In this case, the case we're trying in this room, whether conductivity is leading to impairment --

A. Yes.

Q. -- can that be determined, that causal relationship be determined by observational data alone?

A. I don't believe so, no.

Q. Okay. So you could not use EPA's database, if you had it --

A. I --

Q. -- to determine that cause, could you?

A. I could use EPA's database to determine whether or not conductivity -- increased levels of conductivity lead to an increased risk of impairment. I could use the data to look at that association and that relationship, and it would be limited to the extent that there are limitations in the data.

Q. Okay. And you're testifying that EPA and all these other papers have not established that causation, right?

A. The methods that EPA used were not appropriate for analyzing the relationship that they were starting out to examine, that's correct.

Q. In fact, you think it couldn't have established causation based on the data it had because all it has is observational

data, right?
A. I'm sorry. I'm going to ask you to repeat that to make sure I understood the question correctly.
Q. Okay. You think that EPA would be unable to use the data that it has to establish causation because it has nothing more than observational data, correct?
A. I think, yes, I do not believe they could establish causation based alone on the observational data available to them in the DEP.
Q. So neither could you, right?
A. That's correct. I don't believe I claimed that that's possible.
Q. And it requires something further, like lab results, an experiment, right?
A. Or repeatability of the findings in the observational research or any additional information that --
Q. Okay. So repeatability. If you could -- and that's observational data, right?
A. Sure.
Q. So if things had been repeated in different ways based on the same data and different data, that may be sufficient to establish causation based only on observational data, right?
A. It would depend on the limits of the data, it would depend on the methods employed, and it would depend on the strength of the relationship that had been identified in that

data.

Q. But multiple lines of evidence is an important element in establishing causation, right?

A. Yes.

Q. Have you ever used a data program called R?

A. No, I have not.

Q. Do you know what it is?

A. Yes.

Q. What is it?

A. It is an open source statistical program that is, my understanding, is it's available for free.

Q. But you're not a user of it.

A. I don't use R, no.

Q. I'm sorry. I'm going through my notes and crossing out all the things I've covered.

A. Okay.

Q. The good thing is I'm crossing most of them off.

Let's turn to Joint Exhibit -- I think it's, again, the benchmark page, Joint Exhibit page 482.

A. You said 482?

Q. Joint Exhibit tab 58, page 482.

A. Okay.

Q. You testified about that yesterday, right?

A. Yesterday and today, I believe. This is the linear regression in B-7?

Q. Yes.
A. Yes.
Q. I think you said yesterday that there's missing information there, right?
A. That's correct.
Q. And what information is missing?
A. I'd like to see the p-values for the variables, the independent variables used in the model at a minimum.
Q. What are the p-values?
A. The p-values represent the statistical tests that the regression does to inform the statistician whether or not the predicted variables are statistically significant predictors of the outcome.
Q. So is it your testimony that one could not reasonably determine whether this relationship is statistically significant based on the information on the page?
A. You could calculate with the estimate, the beta parameter estimate and the standard error, I believe you could probably calculate the information necessary to evaluate whether or not it was statistically significant, but it's not straight-forward.

The regression provides that for you, and it would just be very simple if they included that here.
Q. But it can be calculated by someone who knows what he's doing pretty easily, can't it?

A. You probably could calculate it if you really wanted to.
Q. I couldn't, but Dr. King could, couldn't he?
A. If he has the correct formula. But I would remind you that they used the wrong type of regression on this model. So the significance of these estimates are not particularly relevant here.
Q. But the missing information you've complained about yesterday, someone -- you may not be able to understand it, but someone with Dr. King's training can, right?
A. I could do it as well, but I would rather not go to the trouble. It would be nice if they simply provided the information, but I could calculate it just the same as he could.
Q. Okay. So that table shows a slope of regression between conductivity and -- or the relationship between mayfly conductivity and mayfly genera; is that right?
A. I believe so, yes.
Q. Ephemeroptera are mayflies; is that right?
A. Correct.
Q. Okay. Now, isn't -- isn't there a -- doesn't that show a strong decline in slope and therefore a strong relationship?
A. I don't know how strong it is. I don't have any measures of statistical significance here. I also can't tell how conductivity was entered into the model. Did they enter it as a continuous variable? Did they bin it and put it in as

categorical? I have no information about that. So interpreting that estimate is nearly impossible with this information.

Q. That's your testimony, that it's nearly impossible for you based on what you know about this information, right?

A. Based on the information they provide about the model that they did, the information in this table is insufficient for me to make any inferences about the results.

Q. Okay. Turn to Joint Exhibit 29, which I believe you testified about this morning.

A. So is that tab 29?

Q. Yes, it is tab 29.

A. Okay.

Q. Page Joint JE 110.

A. Okay. Yeah.

Q. I think you testified this morning that the data had been truncated, right?

A. He limits the analysis he does here to summer data only.

Q. And why would he do that?

A. He -- as far as I know, I think he testified that it was to minimize the effect of confounding by temperature.

Q. Do you think it was to clarify the analysis?

A. I don't know that that's why he did it.

Q. All right. Is that something that one might rely on, one's "a priori" or "a priore" knowledge to do?

A. If all we were interested in is the effects of the exposure and the outcome in the summertime only, then you might have some justification for only examining data in the summer. However, my understanding, based on the benchmark, is that they used data from all 12 months, all seasons, to do their analysis. So it is unclear to me what the rationale would be for examining this only in the summer.

Similarly, if we were interested in examining the effects of the exposure on the outcome across seasons -- let's say we suspected that season modified the effect of the exposure on the outcome. That's what we talked about, effect modification. We might look at the data from winter, spring, summer, fall, but he only presents the summer data here.

Q. Do you know why this was prepared?

A. Do I know why this was prepared?

Q. Yeah.

A. This was part of his rebuttal report.

Q. The rebuttal report to Dr. Menzie and to you, right?

A. I believe so.

Q. And is the claim that high temperatures are causing a problem with mayflies from Dr. Menzie?

A. I don't know that that's his claim.

Q. If that were the claim, would it make sense to look at the hottest months, the summer months, if you were writing a rebuttal report?

A. What he was doing here was eliminating temperature as a confounder, and I don't see that that has anything to do with temperature causing problems with mayflies in terms of eliminating it as a confounder. You're not going to do that just in the summer. That doesn't eliminate the effect of temperature as a confounder.

Q. Well, Dr. King believes that that's been eliminated a long time ago overall by all the published work, the benchmark, his published work. And those did consider winter temperatures, didn't they, all-year temperatures?

A. I disagree with his belief in that.

Q. I understand you disagree with his belief. I'm just trying to get to the bottom of why he may have used only summer months here.

A. You'll need to ask him.

Q. You don't understand it.

A. No, I don't believe it was a valid way to examine this data.

Q. Okay. Let's turn to 32, which you also testified about this morning. Again, does this rely only on summer data?

A. Yes, apparently it does.

Q. And that's one of your criticisms of it?

A. My criticism is that he was using these to eliminate temperature as a confounder, and doing so by only examining summer months was an inappropriate method to use to eliminate

temperature as a confounder.
Q. This was part of his rebuttal report too, right?
A. That's correct.
Q. Okay. Now, let turn to tab 25, Joint Exhibit 25, page 104, JE 104. You testified about that this morning too I think.
A. Yes, I did.
Q. And I think you said for this, that he couldn't rely only on this table -- is that what you said? -- to form a conclusion?
A. That's correct.
Q. But it's useful for a statistician, isn't it?
A. Oh, sure.
Q. Did you hear Dr. King say he could rely only on this table or that it was the kind of thing a statistician would use as part of his tool?
A. I believe my concerns were related to the comments he had in his report in which this table appeared, but I don't disagree that it's a useful way to visualize your data.
Q. Did you hear Dr. King say anything more than that?
A. I honestly don't recall. I don't recall what he stated.
Q. Does he say more than that in his report?
A. I would need to look at his report.
Q. Now, you've relied in your report on the data presented to you by Dr. Menzie, right? You used it, let's say.

A. Well, he generated some graphs that I relied on in my report.
Q. And all of that is observational data too, isn't it?
A. Absolutely.
Q. So those data couldn't be used to show what is causing, in your opinion, show what is causing extirpation of mayflies, could they?
A. Again, if we are examining the relationship between a particular exposure and an outcome using observational data, it would be difficult to establish causation using those data.
Q. Now, did you hear the testimony yesterday about the Kunz and Kennedy papers?
A. I remember there being discussion about it, yes.
Q. You haven't read those, have you?
A. I have not. At least I don't believe I have.
Q. Can you name an author of any published paper on this subject area that agrees with your assessment here today?
A. I would need to review the literature, and I have not done that exercise yet.
Q. You've not reviewed the literature in this area before you testified here as an expert?
A. As I said, my testimony was limited to the methods that were used in the EPA benchmark and by Dr. King. I have not done a full critique of the body of literature on this particular topic.

MR. LOVETT: May I approach?

THE COURT: Yes, you may.

BY MR. LOVETT:

Q. Have you seen this before?

A. Yes. This is Dr. -- or Sir Bradford Hill's paper from 1965.

Q. And this is the Sir Bradford Hill that you testified about as sort of the father of the method that you apply and epidemiologists apply, correct?

A. The method -- well, Dr. -- Sir Hill developed a set of criteria, if you will, that can be used to evaluate causation.

Q. And you laid it out fully in your report I think --

A. Yeah.

Q. -- didn't you?

A. Yeah.

Q. You listed this methodology in your report, right?

A. I did.

Q. And you testified about it yesterday.

A. I don't think I testified about it yesterday. If I did, I --

Q. We did.

A. -- didn't get enough sleep. Sorry.

Q. In any event, this is a seminal paper in your field, right -- or not paper, but talk.

A. It's seminal in the fact that people refer to it when

evaluating evidence for causation. So, yes, I would say that's true. It is one philosophy of causation.

Q. Okay. It's fair to say that Mr. Hill believes that -- I don't know if he's a doctor or not -- believes that you can establish causation through observational data, isn't it?

A. Actually, Sir Bradford Hill cautions that the researcher not use this as a checklist, that they evaluate all of the evidence available. He provides this as a framework within which to evaluate for causation, but he cautions even in his talk that we should not use it as a checklist.

Q. Sure. That makes sense, but that's not what I asked you. I asked you, Dr. Hill believes, doesn't he, Mr. Hill, that it is legitimate to use observational data to reach causal conclusions?

A. I don't think that's what he says. I haven't read this paper in a while, but I can certainly look at it.

Q. Well, if you want to look at it, go ahead. I thought this was, as I said, a seminal paper in your field.

A. I don't think that that is what he's saying here.

Q. Okay. What do you think he's saying?

A. I think that what he was trying to do -- and he states this very clearly -- is that when we observe an association, what aspects of that association -- and he says, quote, should we especially consider before deciding that the most likely interpretation of it is causation. And he provides us a

framework to evaluate the associations that we are observing.
Q. So what he does is he gives us a list of factors. I won't call it a checklist, but a list of factors that he believes should be used when trying to establish causation, right?
A. Yeah, he gives us a list of things we should consider about the associations that we observe.
Q. And those have been passed down since this paper in the field of epidemiology and is still constantly referred to in the field, right?
A. I think that's a fair statement. I don't know about constantly.
Q. Okay.
A. Okay.
Q. Okay. So let's just look at a couple of them. I don't know how we use it not as a checklist. I don't know how we do that, but --
A. Well --
Q. Let's look at them as factors.
A. Yeah. The caution is that you not simply go through this in rote as a checklist and say, "Oh, I have this. I have that. I must have causation."
Q. Sure, and that makes sense, because you might not have them all, as he says, and still have causation.
A. Well, you might not have them all and still have

causation, correct, or you might have them all and not have causation.

Q. Exactly. But this is the roadmap that we follow.

A. It's a framework.

Q. Okay. So the first thing we look at is the strength of the relationship, right?

A. That's correct.

Q. And he says, you know, a nice sentence down, "I have now reflected for over fifteen years, prospective inquiries into smoking have shown that the death rate from cancer of the lung in cigarette smokers is nine to ten times the rate in non-smokers and the rate in heavy cigarette smokers is twenty to thirty times as great."

So that's strong association, right?

A. That's correct. He was talking about the strength of the risk estimates that had been calculated using statistical techniques; so those risk ratios and odds ratios that we've been talking about.

Q. So that's observational data, correct?

A. That's correct.

Q. And he's taking those observational data and he's using them to show the first prong of his test or factors.

A. He's using it to illustrate a particularly strong effect between an exposure and an outcome. There are other exposures and outcomes that he could have used as an example, though I

don't know if they were available in 1965, but there are other examples of that, yeah.

Q. Well, 1965, there were still a lot of people arguing that cigarette smoking didn't cause cancer, right?

A. Yeah.

Q. Because they didn't have lab tests.

A. Well, they didn't have all of the available preponderance of evidence that we have now.

Q. Okay. But he knew in 1965 -- well, strike that.

A. No.

Q. Consistency, the second prong. "Next on my list of features to be specially considered I would place the consistency of the observed association. Has it been repeatedly observed by different persons, in different places, circumstances and times?"

Do you agree that that's a good thing to look at?

A. Yes.

Q. And isn't that just what we have here? We have a series of different examiners who have gone out, looked at something, and have all reached the same conclusion, except for you and Dr. Menzie?

A. Well, as I said, I have not looked at the body of literature on this topic. I have looked at what the EPA did and their analysis and the methods that they used, and I have provided my testimony regarding those analyses and the

methods.

Whether or not there is consistency depends on whether or not the appropriate methods have been used on the data that is available, and I have not examined that at this point.

Q. Okay. I'm not going to go through all these because some of them aren't directly relevant, things like specificity and temporality. Or they may be relevant and I don't understand why.

Let's go to the biological gradient. No. Plausibility, number six.

A. Sure.

Q. "It will be helpful if the causation we suspect is biologically plausible."

A. Sure. It has to be possible that the exposure could cause the outcome.

Q. Not possible, but plausible.

A. Well, for example, our discussion about gray hair and death, obviously there's no plausible way.

Q. Right.

A. Right.

Q. But with conductivity, certainly it's plausible that conductivity is the cause of impairment, isn't it?

A. That's outside the area of my expertise, but based on the testimony I've heard, yes.

Q. All right. That's fair. Coherence. "Cause-and-effect

interpretation of our data should not seriously conflict with the generally known facts of the natural history and biology of the disease - in the expression of the Advisory Committee to the Surgeon-General."

Now, is that true here too in terms of the question we're looking at with conductivity? It doesn't conflict with generally known facts of natural history, does it?

A. I have not studied the natural history of conductivity and the effects on these bugs or on these streams.

Q. Sure.

A. So I don't have a good answer for you on that.

Q. And all of these are based on observational data, correct?

A. I don't know that Sir Bradford Hill is requiring that the data being evaluated be entirely observational.

Q. In fact, let's have you read the last paragraph of the paper, if you would -- or the second to the last paragraph of the paper.

A. Where it says, "All scientific"?

Q. Uh-huh.

A. He states, "All scientific work is incomplete - whether it be observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to

demand at a given time."

MR. LOVETT: Thank you. That's all I have.

THE COURT: All right. Do you have redirect?

MR. HARVEY: (Nods head up and down)

THE COURT: Let's go ahead and take a break. It's almost noon. We're going to stand in recess until 1:00 p.m. You may step down. Don't discuss your testimony.

THE WITNESS: So can I get my lunch with them?

THE COURT: As far as I'm concerned. As long as counsel understands and explains to the witness you can't discuss your testimony, that's fine with me.

THE WITNESS: Thank you.

THE COURT: As a matter of fact, they should buy your lunch.

THE WITNESS: I believe they are.

THE COURT: All right. We'll stand in recess until one.

THE WITNESS: Thank you, Your Honor.

(Lunch recess from 11:58 a.m. to 1:05 p.m.)

AFTERNOON SESSION

THE COURT: All right. Redirect?

MR. HARVEY: Yes, Your Honor.

REDIRECT EXAMINATION

BY MR. HARVEY:

Q. Miss Kuehn, it was EPA that proposed using epidemiology

to address issues of causation, correct?
A. Yes.
Q. And you've read the benchmark?
A. Yes, I have.
Q. Did EPA express any concerns in the benchmark about epidemiology having roots in the examination of human exposures?
A. No, they did not.
Q. They embraced epidemiology, correct?
A. Yes.
Q. Did they suggest in any way that the rules of statistics or epidemiology change for ecological data as opposed to human data?
A. No, they did not.
Q. Do you recall the pass/fail table that Dr. King prepared in his initial report? You and Mr. Lovett discussed that.
A. Yes, I do.
Q. I think it's Plaintiffs' Exhibit 25.
A. Yes.
Q. I'm sorry. It's Joint Exhibit 25.
A. Yes. I have it in front of me still here.
Q. I think that you and Mr. Lovett had some disagreement about how much weight Dr. King placed on that table. Do you recall that?
A. Yes, I do.

Q. I'd like to put up on the screen that part of Dr. King's expert report, or not.

Let's do it this way. Your Honor, may I approach?

THE WITNESS: There it goes.

BY MR. HARVEY:

Q. Is that the pass/fail table that is in his expert report?

A. Yes, it is.

Q. And then below that pass/fail table, there is some discussion of his conclusions from that pass/fail table. Do you see that?

A. That's correct.

Q. Could you scroll down, Mr. Tyree?

And, Miss Kuehn, can you read for me his ultimate conclusion?

A. He states, "Thus, placing Stillhouse Branch into the broader context of data across the entire state once again shows strong support that conductivity is the principal cause of biological impairment."

Q. So he didn't find this just to be some interesting demonstration of data. He relied on this heavily, didn't he?

A. It would appear so, yes.

Q. Was there any other statistical analysis in his expert report, his initial report?

A. In his initial report, I would need to look at it. I'm sorry. Thank you.

Q. And let me ask it this way. Just looking briefly, do you see any other tables or graphs that have statistical conclusions drawn from them?

A. No.

MR. HARVEY: No further questions, Your Honor.

THE COURT: All right. Recross?

MR. LOVETT: Very briefly, Your Honor.

RECROSS EXAMINATION

BY MR. LOVETT:

Q. EPA didn't say it was going to use epidemiology, did it? It said it was going to adapt epidemiological principles to its study, right?

A. I would need to look at the exact wording, but they certainly stated that they were relying on epidemiologic principles.

Q. Is it fair to say that's what they did? They relied on epidemiologic principles and applied them to their own discipline?

A. They applied them incorrectly to their data.

Q. I understand that's your view, but they applied them to their own discipline, right?

A. Yes.

MR. LOVETT: Okay. That's all I have. Thank you.

THE COURT: All right. Any other questions?

MR. HARVEY: No further questions, Your Honor.

THE COURT: All right. Miss Kuehn, you may step down, and you're excused.

THE WITNESS: Thank you.

MR. LOVETT: Your Honor, I have three exhibits that I used that were not in the notebook.

THE COURT: Use the microphone, please.

MR. LOVETT: Three exhibits that I used that were not in the notebooks, the order from the Southern District of New York, the Fola third supplemental response, and the Bradford Hill paper. And I'd like to mark those as 26, 27, and 28, Plaintiffs', and move their admission.

THE COURT: The order in which you --

MR. LOVETT: Yes, the Southern District -- the order from the Southern District of New York is 26. 27. I'm sorry. 27.

The Fola third supplemental response is 28. And the Bradford Hill is 29.

THE COURT: All right. Any objection?

MR. HARVEY: Not to the Bradford Hill exhibit. I take that as a learned treatise.

The Fola information I think was from a document in this case. I'm not sure under what, you know, hearsay rule he's -- exception to the hearsay rule he's using to admit the court document.

THE COURT: As to which one? As to 27, the opinion

out of the New York District Court?

MR. HARVEY: Yes, Your Honor.

MR. LOVETT: The opinion from the New York District Court?

MR. HARVEY: Yes.

MR. LOVETT: Well, the Court can take judicial notice of it.

THE COURT: Is that microphone on?

MR. LOVETT: How do I turn it on? Is that better?

THE COURT: It is.

MR. LOVETT: The Court can certainly take judicial notice of another order from a court. It's a government document too, but I don't care so much if it's admitted. It should be admitted, though, but the Court can certainly rely on it. It's an opinion from another federal court.

THE COURT: Well, I'll reserve ruling on the District Court of New York opinion and order.

I'll admit 29. 28 is the Fola supplemental response. My recollection is that the discovery rules provide that --

MR. HARVEY: I didn't mean to object to that, Your Honor.

THE COURT: Okay.

MR. HARVEY: I have no problem with that.

THE COURT: All right. 28 is in and 29 is in. And I'll reserve on 27. All right. Ready to call your next

witness?

MR. MCLUSKY: We are, Your Honor. Dr. Charles Menzie.

CHARLES MENZIE, DEFENDANT'S WITNESS, SWORN

THE COURT: Before you start, are you going to be using the notebooks?

MR. MCLUSKY: Not a lot of them.

THE COURT: Well, I'm going to ask you to come up and help order these notebooks so that -- you know what you're going to be asking to refer to. It's difficult for the witnesses to find them all up here.

MR. MCLUSKY: Do you mind if I spend a moment with Mr. Tyree --

THE COURT: That would be fine.

MR. MCLUSKY: -- to determine which volume they're in?

THE COURT: Sure. That would be fine.

I'm trying to keep you from having to do heavy work here.

THE WITNESS: I had mentioned it looks like a workout.

THE COURT: All right.

DIRECT EXAMINATION

BY MR. MCLUSKY:

Q. Dr. Menzie, can you tell us your full name, please.

A. Dr. Charles A. Menzie.

Q. For whom do you work and where do you live?
A. I work for a company Exponent, Inc., and I live in Troy, New York.
Q. What do you do for Exponent?
A. I'm the practice director of their biological and ecological sciences practice.
Q. Okay. But tell us what you actually -- kind of what disciplines you practice. What do you do?
A. My primary area of expertise and practice is in the areas of risk assessment, causal analysis, and ecology, especially aquatic ecology.
Q. Okay. And then within the fields of risk assessment and causal assessment or causal analysis, is it environmental and health-related primarily, or are you off into physics and other things?
A. It's exclusively environmental and health.
Q. Explain briefly what those fields are and what disciplines they entail.
A. Risk assessment is a discipline that involves estimating the health or environmental risk to either people or the environment or the ecology as a result of either chemical exposures or physical exposures or biological exposure.
Causal analysis is an evaluation of the factors that have caused or might cause a particular set of conditions to come into being. So causal analysis is often applied after the

fact; for example, a fish kill or change in biological community, and the question is what is causing that, to apply causal analysis.

Q. And what scientific disciplines are involved in a day-to-day basis in your work?

A. Basically understanding the nature of exposures, so fate and transport, the implications of magnitudes of exposure either for temperature or chemistry, and then toxicology, aquatic ecology, and decision analysis.

Q. Let's look briefly, then, at your history with each of those disciplines, and I direct your attention to Joint Exhibit 68, which I believe is your -- can you confirm it's your CV?

A. It is.

Q. Can you tell us briefly your educational background?

A. All my degrees are in biology. I have a bachelors, a masters, and a Ph.D. in biology, with an emphasis in my Ph.D. on ecological sciences.

Q. And what was your Ph.D. thesis in?

A. It was on the production of insect communities, aquatic insect communities in a part of the Hudson River.

Q. Since you obtained your Ph.D., can you give us a brief summary of what you've been doing?

A. I received my Ph.D. in the mid '70s, and I have been working in the consulting field in these fields of risk

assessment, aquatic ecology, ecology, and causal analysis pretty much ever since.

In the early '80s I formed a company that specialized in these fields, and then in 2006 I joined the company Exponent to head up their practice in this area.

Q. In your experience, your professional experience, have you had opportunities to use the type of multi-metric indices that have been testified to in this trial?

A. Those go back a long way, and so I remember seeing them when I was first working in the field and working with EPA and helping them kind of review their various programs. So these are familiar techniques.

Q. And did you utilize them in your work for the past several decades?

A. Yes.

Q. Routinely?

A. Excuse me?

Q. Routinely?

A. Yes.

Q. Are you a member of any societies that -- professional societies that relate to aquatic ecology or risk assessment?

A. The two main societies that I'm a member of are the Society of Environmental Toxicology and Chemistry and the Society for Risk Analysis.

I'm also a member of other societies that deal with

ecology and estuarian sciences, for example, the Estuarian Research Federation and a variety of other societies.

Q. What is the society of Risk -- is it Analyst or Analysis?

A. Analysis. That's the society of professionals that deal in the field of risk assessment, and it can be risk assessment that would include the engineering as well as the health and environmental sciences.

Q. And then the other outfit was called what?

A. It's the Society of Environmental Toxicology and Chemistry, or SETAC. It's the society where most of the professionals that work in the field of environmental toxicology, chemistry, and risk assessment have as their professional home.

Q. And does that involve a fair amount of work in the area of toxicology to aquatic organisms?

A. Much of the early work for SETAC related to evaluating toxicities, toxicology, or aquatic organisms.

Q. Have you held any leadership positions with the governing councils of either of those organizations?

A. I was a member of the board for SETAC North America and then served on the SETAC World Council. And then I was also a member of council for the Society for Risk Analysis.

Q. And how many people were on the board of councils of those two organizations?

A. Might be eight people.

Q. On each?
A. On each.
Q. SETAC, do they have a journal?
A. They have two journals. One is *Environmental Toxicology and Chemistry*, and there's another one called *IEAM*.
Q. And the first you just mentioned, is that the same journal in which Suter and Cormier published the papers we've talked about here in this trial?
A. Yes, it is.
Q. Do you have publications in peer-reviewed journals?
A. Yes, I do.
Q. Do you know approximately how many?
A. Approximately 50.
Q. Directing your attention to your CV, which is Joint Exhibit 68 -- and I'll start on page 934, I believe -- and I just want to go through a couple of these.

There's a paper on the first page, I think it's pronounced Richkus, Menzie et al. "Application of an ecological risk assessment for evaluation of alternatives considered for restoration of oysters in the Chesapeake Bay."

A. That's correct.
Q. Can you tell us what that's about?
A. It was a novel risk assessment. This basically was in response to a proposal to introduce a new oyster species to the Chesapeake Bay, and I was asked to construct and provide

an analysis of all the ecological risks that might emanate from that action, as well as all the alternatives to that action.

So it required considering the overall ecological structure of the Chesapeake and all the organisms and their interactions. And that work was used to underpin the decisions that were made about that particular action for the Bay.

Q. On page 936 there's a paper by Magar or "Mager." I'm not sure how you pronounce that. M-a-g-a-r, et al. It's entitled "Parsing ecological impacts in watersheds."

What's that about?

A. This is one of a number of pieces of work I was involved in. This relates to recognizing that watersheds have many things going on within them that can affect the ecology and biology. And so this is a paper about how to distinguish among those causal factors.

Q. The next one on the same page is von Stackelberg and Menzie. What's the title of that one?

A. "A cautionary note on the use of species presence and absence data in deriving sediment quality criteria."

Q. And what is that about?

A. There had been a fair amount of work being done on using species presence and absence data to derive levels of exposure in sediments that were considered potentially problematic to

the ecosystem. And that work had involved a number of statistical manipulations.

And so Dr. von Stackelberg and I looked at that and recognized that the statistical manipulations that had been made were creating artifacts, and so that the values that were being derived were not informative about the levels that were causing effects. And so we presented it to the -- in the *Journal of Environmental Toxicology and Chemistry*, basically our results of that and reported that out.

Q. On page 398, there's one, Menzie on chironomids.

A. Yes. This one goes back a ways. This one relates to some of my early work on the insect fauna, aquatic insect fauna in the Hudson River, and whether it be looking at the community of insects or the secondary production.

That work was used to -- by many since to kind of estimate secondary production in aquatic systems.

Q. And secondary production refers to --

A. Production of insect biomass.

Q. As opposed to primary --

A. Primary production, that's correct, which is plants.

Q. I'm sorry. Go ahead.

A. That it's.

Q. There's an article by Mauer, I believe Leathem, and Menzie on 938 as well?

A. Yes. Back in the -- I would guess it's probably in the

1980's, I was looking at the influence of discharges to marine environments on the benthic community structure out in the outer continental shelf. And this paper concerns that work where myself and two professors from the University of Delaware got together and presented the results of that work.

Q. And then on the same page, I believe there's one, Menzie and Cura. You may be on the wrong page.

A. Menzie and Skinner -- Menzie, Cura, and Skinner on page 938.

Q. What's that about?

A. Throughout much of my career -- in fact, most of my career -- I've looked at the effects of temperature on communities. And in this particular -- for this particular paper, I had been working with the State of Pennsylvania and with the utility to kind of come up with a methodology for evaluating the implications of temperature modifications in the Susquehanna River. And so this particular paper put together a methodology that kind of combined the various lethal but also sublethal kinds of influences of temperature on aquatic biota and put that together with a spatial model that was able to predict where those effects might occur.

Q. All right. Is that a fair sampling of some of the literature you've prepared? Is there anything else you want to call to our attention?

A. I think probably the one thing I've been working on quite

a bit -- it's been used by the National Academy of Sciences and others -- is approaches for dealing with multiple stressor problems. So when you have many things going on simultaneously in the environment, how do you put that together, how do you come to understand that.

And so I was asked by EPA to develop a methodology for thinking about that some years ago. And one of the papers in here concerns that particular work. It appeared in the National Institute of Health's journal and has been since picked up and is being utilized to guide ways of thinking about multiple stressor problems in the future.

Q. Putting aside your publications for a minute, let's talk briefly about some projects you've worked on in the recent past.

You told me about one you've worked on for Uruguay and the International Court of Justice I think it is.

A. Yeah. That was an international dispute between Argentina and Uruguay. I mentioned it because it exemplifies a causal analysis in which Argentina was making some claims with regard to the Uruguay River and bringing those claims against Uruguay.

Because it was two countries involving an international, you know, border -- that is, the Uruguay River -- the case itself was elevated to the International Court of Justice.

Q. And you served as an expert in that case?

A. That's correct.
Q. In what areas?
A. Basically the issues were what factors related to the operations in Uruguay -- it was a mill plant -- might affect the aquatic ecology of the Uruguay River, and it addressed claims that had been made by Argentina that certain things had happened in the Uruguay River, or might happen, were valid or not.
Q. And you mentioned you've written papers or continued to work on the thermal effects of -- I presume it's cooling water from electric generating units on receiving waters?
A. That's correct.
Q. What type of work have you continued to do after your publications?
A. There continues to be evaluations of thermal discharges on aquatic systems, and these generally fall under what are known as 316(a) of the Clean Water Act. So they're thermal variances.

So every few years there's reassessments made of those kinds of effects. So a number of power plants where there are questions about what stressors are causing certain things to happen and temperature is involved, that problem becomes part of what I do and take a look at.

Q. Has some of that involved the review or analysis of impacts on macroinvertebrates?

A. It has over the years, yes.
Q. And what kind of things have you found in those --
A. Well, near the regions where thermal discharges enter aquatic waters, it is possible to get shifts in benthic macroinvertebrates, as well as redistribution of fish populations in other parts of the community.
Q. Even with nonlethal temperatures?
A. Yes. It's simply a response to the temperature variance.
Q. Do you have any teaching experience?
A. I do. I have teaching experience.
Q. Would you tell us a little bit about that?
A. The major universities I've taught at are Boston University, University of Massachusetts, and University of Maryland at Baltimore County.
Q. And what have you taught?
A. The most common course I've taught is on risk assessment, environmental risk assessment, but I've also taught courses on ecology, oceanography.
Q. Were you asked by EPA to review the benchmark that's at issue in this case?
A. I was.
Q. Who at EPA asked you, if you know?
A. It probably came to me by either -- it usually comes through a company that has contracted with EPA. So I think in this particular case, I believe it came through Versar. And

basically Versar is a company that has a contract, as do other companies, with EPA for identifying peer reviewers for various EPA issues. I've done a lot of peer review for EPA.

Q. And you conducted a review for EPA of the benchmark, as I understand it.

A. I did.

Q. Have you qualified before this Court in the past as an expert in risk assessment and aquatic ecology?

A. I believe so.

Q. Do you regard causal analysis as part of the risk assessment discipline?

A. Yes.

MR. MCLUSKY: Your Honor, I'd move to qualify him as an expert in those fields again.

THE COURT: I'm satisfied.

BY MR. MCLUSKY:

Q. Dr. Menzie, your work in this case -- I assume you've sat through those parts of the testimony you were permitted to sit through since the beginning of the trial, haven't you?

A. That's correct.

Q. Have you read the expert reports of the plaintiffs?

A. Yes, I have.

Q. And presumably you reviewed the benchmark since EPA asked you to do that, correct?

A. Yes, that's correct.

Q. You've reviewed the Suter and Cormier papers that have been discussed?
A. I have.
Q. Have you reviewed the databases that the -- the database that the benchmark relies on?
A. Pretty extensively, yes.
Q. Have you been to the Stillhouse site?
A. I have been.
Q. Have you reviewed reports by DEP of its visits to the Stillhouse site?
A. I've reviewed those.
Q. Okay. Is it fair to say that at least as to the general causation question, the plaintiffs rely primarily on the presence or absence of certain types of bugs to demonstrate that conductivity causes WVSCI scores to drop below 68?
A. Yes, that's correct.
Q. Do you agree generally that those conclusions are supported by the benchmark and the other literature you've heard testified about here?
A. With respect to Stillhouse, I believe --
Q. Well, let's go just generally to the benchmark. Put Stillhouse aside for a moment.
A. Okay.
Q. Do you believe that the conclusions of the benchmark are generally supportable based on the testimony you've heard and

in your own review of the benchmark?
A. I don't.
Q. Why is that, just very briefly?
A. When I had an opportunity to review in depth the database on which the benchmark relies, in addition to my own observations at -- in previous cases, I came to realize that the -- that there were some problems associated with reliance upon the underlying data and the way in which those data had been statistically evaluated and presented. That became much more clear to me as I looked into it.
Q. Okay. We'll get into that in a little more detail in a second.
Do you believe that the site-specific or specific causation analysis presented by the plaintiffs stands up?
A. I don't.
Q. Why not?
A. I think that the plaintiffs rely primarily on literature and basically say, "Well, if it happened elsewhere or if this report says it's so, then it must be so here too." And that's basically applying general causation to a specific set of circumstances without considering a full range of causal factors at that location.
Q. All right. And before we go any further, I think some of this was covered by Dr. Palmer, and I apologize. As I understand it, conductivity is just a measure of the ability

of water to conduct electricity.

Is that a fair characterization of it?

A. That's what it measures.

Q. And ions are positively or negatively charged molecules or atoms?

A. That's correct.

Q. And the accumulation of those can create conductivity? Is that a --

A. Conductivity can increase as the ionic composition changes.

Q. Okay. Is it fair to say conductivity is a characteristic of many substances but is not itself a substance?

A. That's correct.

Q. Okay. Let me divert here for just a moment because I'm not sure this has really been asked this way.

Is it your understanding that EPA or Suter and Cormier have determined that some synergistic properties of alkaline mine drainage cause impairment and that the role of individual ions can't be teased out or that it's likely there are one or more ions that are part of that mixture that may have a causal influence on biota but that no one has done that work to actually tease them out?

A. I think it's the latter case.

Q. Okay. And Mr. Lovett talked about pH being a characteristic and not a thing itself and is regulated. Do

you know whether pH is different in the sense that it is regulated at pH per se as opposed to conductivity?

A. Yes. PH has been something recognized for a long time as being harmful, whether it's too much or too little; in other words, high or low, basic or acid.

Q. And is it considered harmful regardless of what the substances are that are causing the pH to be high or low?

A. Yes.

Q. So that if it was sulfuric acid or carbonic acid causing a low pH, that wouldn't matter in terms of regulating pH.

A. Right. It would still be pH.

Q. All right. The WVSCI, the West Virginia Stream Condition Index, I think we have a demonstrative exhibit, but could you tell us briefly what the WVSCI is?

And, Mr. Tyree, if you could -- you have a demonstrative exhibit just to explain the WVSCI for us.

A. Sure. If we could bring that up.

Q. And it's up now. You can see it?

A. Sure.

THE COURT: You also have a monitor.

THE WITNESS: You have this one?

THE COURT: Yes, I have this one.

THE WITNESS: Yes.

THE COURT: If you bend down, would you take that microphone with you.

THE WITNESS: I think I'm going to look at the one on my left.

Basically the whole idea behind the WVSCI or the West Virginia Stream Condition Index was to capture the characteristics of what the animal life looks like in a reference water body.

So EPA contracted with Tetra Tech to develop something very specific for West Virginia and which has become basically the value, the procedure, that the state uses to evaluate waters with regard to biological condition.

So the WVSCI is made up -- the key idea behind the WVSCI is that it doesn't depend on one thing. So it's not, for example, numbers of mayflies or numbers of chironomid insects, but rather it kind of puts all the information together on the various invertebrate taxa that are present at a location.

So there are these components that are brought together to kind of provide a more complete picture of the ecological conditions and perhaps even ecological function to some degree of an area as represented by these animals.

And so the groups include the number of -- the first group of animals being mayflies, stoneflies, and caddisflies, how many of those there might be. And when those go up, the WVSCI goes up, the reason being is that in the reference water bodies, those water bodies have a lot of those kinds of animals. So it's closer to what the reference water body

looks like.

And then the number of families or the number of taxa. The more of those, the higher the WVSCI. The percent composition that the mayflies, stoneflies, and caddisflies make of the total amount of animals that might be present. So a low amount might be 5 percent. A higher amount might be 90 percent, for example. And as that goes up, the WVSCI goes up.

Now, there's some things that decrease the WVSCI that are present, again on a fractional basis or a percentage basis. So if you have a lot of these midges called Chironomidae -- and you heard about them a lot yesterday. Those are the little tiny guys that if you're a fly fisherman or woman, you put on to catch, you know, to catch fish. They're very, very tiny. But because they're not represented very much in reference water bodies, the WVSCI goes down if they increase in percentage. So the WVSCI also goes down if there's a lot of one or two things. So if you have, like, a bloom or a huge amount of any of these things -- could be any of these groups -- that would decrease the WVSCI score.

And then finally there's an index that Hilsenhoff developed sometime ago called the HBI, and that's a mechanism for kind of considering tolerant and intolerant animals and calculating this score. And when that increases, the WVSCI just decreases. So the idea is kind of pull all things

together to get an overall sense of what's there, but the key thing is that this is ground truth to the reference areas. So the WVSCI changes as you depart from reference area conditions.

BY MR. MCLUSKY:

Q. And, Doctor, let me stop you. A reference area, is that an area chosen from a group of relatively undisturbed streams?

A. Yeah. What Tetra Tech did was to collect information from many reference areas or reference dataset to construct the WVSCI score and then used that -- they did a fair amount of analysis to kind of come up with a metric that would be most useful for West Virginia.

Q. Okay. And I think it goes without saying, but all the animals you talked about, they're all aquatic insects, right?

A. They're almost all aquatic insects. This HBI, this last index, can include things that are not aquatic insects, some things like worms and some other kinds of things that might be in there.

Q. What kind of things can affect WVSCI scores?

A. Well, anything that can affect the populations of any of those animals that are in the score can affect the WVSCI score. So if, for example, you have a habitat alteration or change in temperature or change in flow velocities or anything that is different about the aquatic habitat relative to the reference water body can affect those populations.

Q. That can include things like embeddedness?
A. Very much so, because if -- much of the reference water bodies provide opportunities in the substrate for animals to hide out, tuck in behind rocks and pebbles and whatnot. And if you cover those with a silt or some other material and kind of fill those spaces in, those animals that would be there taking advantage of that habitat would not have a home.
Q. Do you agree that the multi-metric indices themselves were not designed to predict or determine the precise cause of changes to the insect makeup in a stream?
A. It's not intended for that. It's just really a representation of what you should expect that reference -- in the reference dataset.
Q. We'll return to this in a minute, but based on your trip or trips to Stillhouse and your review of the DEP data, does Stillhouse resemble a reference stream at all?
A. It doesn't look like a reference stream. It is quite different from a reference stream.
Q. Let's go to the database and the data used in the database. Did you examine the database that was used in the benchmark?
A. I did.
Q. Where did you get it? Where did it come from?
A. Ultimately it comes from West Virginia. They maintain the database. There are probably several sets of the database

around. I think we have one of the more recent sets of the complete database, but it originates with West Virginia DEP.

Q. Was it specifically compiled for the purpose of discerning whether particular inputs to a stream cause changes to the benthic macroinvertebrates?

A. It wasn't really designed to be diagnostic in that way.

Q. What was it designed to do, if you know?

A. Part of it, certainly the biology part of it was designed to provide the biologists in the West Virginia DEP with some sense for how different a particular water body was from the reference dataset. So that is shown by a lowered WVSCI score, and that can be a basis then for listing.

Along with the collection of the biology data, various measurements are made at each location, but that program was not established to be a diagnostic program but to collect information specific to a location at a particular point in time.

Q. Now, your review of the -- and this is the same data that was used in the benchmark, then; is that correct?

A. That's correct.

Q. And some subset of that data was used in "How Many Mountains Can We Mine?"

A. Yes.

Q. When you reviewed that database, did you make any determination whether the data was of sufficient quality to

adequately analyze potential impacts of things like temperature and habitat?

A. Well, I did. I looked at it from that point of view to see what you could really say about the influence of these other factors. In particular, at the time I was looking at temperature because I had noticed in a previous case that there was a systematic difference in temperatures between different water bodies. And so I went and looked at the database to see how temperature had been dealt with and the nature of the temperature data; and I noticed that it was basically, as you've heard before, you know, snapshot data.

Q. And we've heard a little bit about this, but what are the problems with snapshot data in determining the role of temperature with respect to the macroinvertebrates?

A. Well, any measurement of temperature would not be considered representative of the stream but yet has been used by most folks that have -- well, certainly by EPA, as if it were.

Q. So a temperature recorded in April would essentially be used to characterize a stream throughout the year, for example?

A. It would be the only temperature measurement available for the stream.

Q. It wouldn't catch the variability and the seasonal data.

A. That's correct.

Q. I think people talked about it's like trying to take clips from different movies and assemble a whole new movie together.

A. That's right. It's like having a frame from a couple hundred different movies collected over different years and different seasons and different days and trying to make a story out of that.

Q. Had you figured that out when you did the review of the benchmark for EPA?

A. I had not figured that out.

Q. Why not?

A. We were not asked to review that. I had no knowledge of the quality of the data at that time.

Q. Did you even have the data -- access to the database when you reviewed the benchmark for EPA originally?

A. I wasn't provided with any of the data or any summary of the data.

Q. Would you have expected members of the SAB panel or the SAB to actually review the underlying databases as part of their review of the benchmark?

A. I wouldn't.

Q. That would be an unreasonable assumption, that they would spend that kind of time?

A. I think so. It takes considerable time to kind of dig into it.

Q. All right. So did you take any steps, then, to figure out whether -- how did you figure out the data was inadequate to characterize your own temperature, and did you do anything to try and see if the data could be assembled in a different way to tell you anything?

A. Well, I was aware that -- of the limitations of the data in terms of temperature, and I also had a priori knowledge of the importance of temperature because I had worked with temperature for decades. So I knew that temperature was important and really shouldn't be dismissed.

And so then I kind of wondered why it was that temperature was not considered as important as it should be and had been dismissed really in some of the previous cases that we've been involved in. And a large explanation of that is sort of the nature of the data. All of the data that you've seen so far on temperature is snapshot data from all the studies done everywhere, as far as I know.

And then I sat down and thought about, well, how can we work with snapshot data to get a better sense for the role temperature might be playing here. We have all these frames from different movies. Is there some way to kind of distill that down to make any sense of it? And that's what I set out to do.

Q. And what was the first step you took in doing that?

A. Well, the first thing was, as a biologist, I said, well,

let us, you know, let us have the animals inform us about what temperatures they prefer to live in. And I knew that temperature was varying throughout the year, but I concluded, as you kind of heard earlier, that the -- at least in terms of thinking about possible thermal stresses and optimal temperatures for animals, that I would select the summer months when temperatures would be at their highest.

And so I, being a biologist and being familiar with temperature and invertebrates and fish and whatnot, I chose to start there and have the animals inform us about the temperatures in which they prefer to live.

Q. Okay. Now, did you look at all the animals that were in the EPA database, or did you narrow it down to the animals that were considered either sensitive or tolerant to conductivity?

A. Well, the issue was -- the thing that I had noticed was that -- and I knew this a little while back from looking at the data -- was that I saw that in the summer that the animals that were being considered sensitive to conductivity were also animals that were typically associated with cooler waters.

And so I thought there was a possibility that as landscape changes were occurring, not only was, you know, conductivity changing as a result of landscape alterations, which happens in any kind of landscape alteration, but perhaps conditions were being set in motion for being able to increase

temperature; these things were happening together.

Q. I want to take a step back. How did you identify -- you mentioned there were insects that were sensitive to conductivity.

How did you identify the world of insects that were sensitive to conductivity and those that were not, were more tolerant?

A. Well, there were two lists I could work from. And the question I asked was, are the animals that are sensitive or tolerant to conductivity also found in cooler or warmer waters? Could temperature be explaining this shift that has been attributed to conductivity?

So I looked at two lists, and I looked at the work that Bernhardt et al. had done, including Dr. King's part of that, and the work that EPA had done. And they had identified genera that were either sensitive or tolerant --

Q. To --

A. -- to conductivity. And so then the question is, are they also -- do these also separate from one another not only on the basis of conductivity but on the basis of temperature.

Q. All right. Mr. Tyree, could you put up Joint Exhibit 70, which is page JE 954.

If Mr. Tyree makes that a little bit bigger, maybe we can talk about it.

A. So, Your Honor, this is just a figure from my expert

report; and what it shows is just contrasting, to begin the discussion, on the top are two panels that are genera of insects that are considered sensitive to conductivity, and on the bottom are examples of two genera that are considered tolerant. And on the X axis is temperature, and on the Y axis is sort of the probability of finding that particular insect in the water.

So I selected three months in which to extract data from the West Virginia database to do this analysis. They are June, July, and August, with the idea being that this would be a time of the year, a period of the year that would likely be more stressful to aquatic insects such that the animals that prefer cooler waters would be in those waters, and the animals that could live in warmer waters would be found in those waters.

The dashed line along the bottom of the figure is at the 90th percentile. So you kind of see that if you -- you would read that, if you could come down and hit that dashed line and to the left of that would be where 90 percent of the animals were found during those months. And as you can see from comparing the top to the bottom, the two sensitive species tend to be found in cooler waters relative to the two that are at the bottom.

So that was something that I looked at for all of these genera.

Q. And to make sure I understand, we have some demonstrative slides that explain a little bit more about how you made Joint Exhibit 70. Do you have some slides that help explain that?

A. I do.

Q. Okay. Mr. Tyree?

A. So just to give you an example, this is a -- one of the --

Q. Let me back up. Is this line, the stair step line on this demonstrative exhibit actually taken from the prior exhibit?

A. Yes. So this is an example of how I arrived at the statistics.

MR. LOVETT: I'm sorry. Where is this?

MR. MCLUSKY: This is a demonstrative exhibit. It's data taken from Joint Exhibit 70 and just explains how the --

MR. LOVETT: When was it prepared?

MR. MCLUSKY: We're not moving it as an exhibit. It's a demonstrative exhibit just to explain how he made Joint Exhibit 70 and how he did his work.

MR. LOVETT: Do you have a copy of it that we could have?

MR. MCLUSKY: I do not.

MR. LOVETT: Well, will you make it available to us?

MR. MCLUSKY: Yeah, sure.

THE WITNESS: So this is one of the -- well, this

particular animal, *Bezzia*, is the one that was found to be most sensitive to conductivity in the "How Many Mountains" paper. And this is that same plot. So basically you follow that line down, and this says that 50 percent of those animals are present above and below the median value, which I've shown there so you can kind of recognize what that is, a little bit above 15 degrees Centigrade in the summer. So 50 percent is to the left, 50 percent to the right of that dashed line.

Okay. Next. And then compare that to a genus that's tolerant to conductivity. I've plotted -- just put this plot together. This is just comparing one genus that's sensitive to conductivity and one genus that's tolerant to conductivity, but in this case I'm comparing them in terms of temperature.

So one of these lives in cooler waters, and one of them lives in warmer waters in the summer.

BY MR. MCLUSKY:

Q. So this shows me the dropped -- the vertical dotted lines are showing the median point of the population of two different types of insects, a sensitive one and a tolerant one; is that correct?

A. That's right. So the first one, its median is a little above 15; and the second one is above, as you can see, well above 20 degrees.

So these two animals would be expected to be found in waters of different temperatures based on this analysis.

Q. And did you do some analysis like this for 20 insects that were deemed -- or 30 --

A. I did the analysis for the 30 most sensitive genera and the 20 most tolerant genera --

Q. Okay.

A. -- to kind of contrast those two groups.

Q. And was that work then embodied in the Defendant's Exhibit 6, which is appendix E to your report?

A. That's correct.

Q. Just scroll through that very quickly, Mr. Tyree. I don't intend to spend any time on it.

Appendix E just shows the same thing essentially as Joint Exhibit 70 but for 50 different insects; is that correct?

A. Right.

Q. All right. What was the next step you did with these data, then?

A. Well, for each of those, as you see in this picture for a moment, I calculated the statistics, the median at which that animal -- you know, the temperature at which that animal is found in West Virginia waters. And then I also calculated the 90th percentile, the value that bounds 90 percent of the animals.

Q. All right. Mr. Tyree, would you put up Joint Exhibits 71 and 72, please.

And, Dr. Menzie, can you confirm that these are the

product of the work you've just described?
A. That's correct. So, Your Honor, on the left panel there are the 30 most sensitive genera to conductivity, but now I'm showing the temperature for them; and on the right, the 20 most tolerant ones. And, again, I'm showing the median temperatures in blue and, at the 90th percentile, the number that bounds 90 percent of them, in green.
Q. Now, the 90 percentile number means 90 percent live to the left of the little green marks?
A. Right.
Q. And just looking at these, were you able to discern any patterns? The left-hand one is which? The sensitive insects?
A. That's correct. Those are the ones that would be considered sensitive to conductivity.
Q. And Exhibit 72, which is on the right there on the same page here, are the tolerant insects?
A. That's correct.
Q. Looking at those -- and I have a hard time seeing it from here, but can you discern patterns of where those bugs live temperature-wise as between the sensitive and the tolerant bugs?
A. Well, if you generally go down the -- the median values for the sensitive ones on the left panel, you'll see that most of those blue squares are down below 20 degrees Centigrade. And if you go over to the right panel, you'll see many of

those blue squares the median values are above 20 degrees.

So, for example, that could be a way of kind of quickly contrasting the two groups.

Q. And did you take these data and plot them in some other fashion to show us a little bit more information?

A. Yes. A customary way of plotting these is to use something called a cumulative probability plot, which just kind of takes these data and orders them from least to most. So I did do that.

Q. Mr. Tyree, would you put up Joint Exhibit 73, please?

And, Dr. Menzie, can you confirm that this is the product of the work you just mentioned?

A. It is.

Q. Okay. Explain to us briefly what this is. And I understand you have some demonstrative exhibits to explain how you did it, but tell us briefly what Joint Exhibit 73 represents.

A. Well, I've talked about two groups of insects, the insects that are considered sensitive and the insects that are considered tolerant. And I've talked about two statistics, the median value, which is sort of the center point of where you'll find these, and the 90th percentile, which is sort of an upper bound.

So on this particular figure, there are four lines. There's a median for each of the sensitive and the tolerant

ones, and then there's a 90th percentile, and I can build this up, kind of explain it a little bit further.

Q. Mr. Tyree, would you go to the first demonstrative slide here.

And explain, if you could, Dr. Menzie, how you put Joint Exhibit 73 together.

A. Okay. So this first line for those 30 sensitive genera, this is the median values from the lowest to the highest, just kind of arrayed in what's called a cumulative probability distribution, from the lowest to the highest, for all 30 that are considered most sensitive to conductivity. So that's the first line.

Q. Okay. The next line up? The next line shows what?

A. This next line is the median for all of the 20 genera that are considered most tolerant to conductivity. And as you can see, it's shifted to the right of the first line.

THE COURT: This is the green line on Exhibit 73?

THE WITNESS: Let me see 73.

MR. MCLUSKY: It should be, Your Honor. Yeah. We should have used the same colors, but --

THE COURT: I just wanted to be sure.

THE WITNESS: Okay.

BY MR. MCLUSKY:

Q. And then --

A. Then added the 90th percentile to that graph. And then

so you can distinguish the two groups for the purpose of visualization here, as an example, filled in the colors on those. So that would be the color that represents the --

THE COURT: Excuse me. Back up, because it appeared to me that on Exhibit 73, the blue dotted line, which is the 95th percentile, as I understand it, fell to the left of the green or orange line, which is the tolerant taxa median. And on what you just showed, doesn't -- okay.

Now, go back to -- see, there's a difference there where that blue dotted line --

MR. MCLUSKY: I agree. These are just demonstrative, but I agree.

Dr. Menzie -- may I approach, Your Honor?

THE COURT: You may.

MR. MCLUSKY: I'd like to show him what you're talking about.

BY MR. MCLUSKY:

Q. I'm going to show you Joint Exhibit 73. The judge is saying on the demonstrative exhibit, the dotted line is to the right of the --

A. Yeah. I can maybe take this and explain it to the judge.

THE COURT: Well, you need to do it on the record. And if you're saying that it's, on the demonstrative exhibit, it's just --

THE WITNESS: A little bit different.

THE COURT: -- mislocated a bit and that it is based upon and should be the same relationship between the blue dotted line and the green line on Exhibit 73, that's fine.

THE WITNESS: Okay.

THE COURT: I just didn't understand if it was suddenly something different or significant.

THE WITNESS: Okay.

THE COURT: Okay.

BY MR. MCLUSKY:

Q. In any event, the demonstrative exhibit generally explains how you compiled Joint Exhibit 73; is that correct?

A. That's correct.

Q. Now, is the 90th percentile -- I'm sorry -- the median temperature line for tolerant taxa misplaced on the demonstrative exhibit?

A. I don't believe so.

Q. Well, the judge pointed --

A. I'd have to look at them together, yeah.

Q. In any event, what -- go ahead to the next two slides, if you would. Just explain what they generally show.

A. So this would fill in the space between the median and the 90th for each of the sensitive and the tolerant.

Q. Okay. What are they telling -- what is the picture telling us?

A. That basically these two groups of insects also were

separated from one another on the basis of temperature.
Q. So the left-hand lines, the solid lines, are the ones that show that 50 percent of the animals live below that, 50 percent above?
A. That's correct.
Q. And then the 90th percentile lines are the line below which 90 percent of the bugs and only 10 percent live.
A. That's correct.
Q. All right. Did this tell you anything about -- so you see a difference in where bugs live based on temperature, whether sensitive or tolerant, to conductivity; is that correct?
A. That's right.
Q. Okay. So does this tell you whether it was a thermal zone or area where you saw a shift from one type to the other?
A. Well, what I wanted to do is then to see whether the waters of West Virginia -- the water temperatures of West Virginia were such that one might expect the presence of one or the other of these groups or some combination of them. And that would be important because it could represent how temperature might bring about a shift in the composition of the macroinvertebrate fauna.

So using the literature and using these figures, I chose to -- I chose two temperatures to kind of -- as a gauge for the eye and kind of thinking about how water temperatures

might influence the presence and composition of different invertebrate taxa, including insects. And those temperatures were 19 degrees Centigrade and 21 degrees Centigrade.

Q. Okay. Let's go to the next exhibit, which would be Joint Exhibit 77, I believe. I'm sorry. You've got on the -- this thermal transition you talked about, you just put it up on a demonstrative exhibit; is that correct?

A. Yes. And this is really used to -- I'll be talking about this because it's used to guide the eye, but I drew these lines at the approximate locations of where the 50th percentiles kind of top out.

So if you look on the left-most, you'll see that the median values increase and then begin to taper out around 19 degrees. And on the second line, it kind of gives you the same piece of information roughly for the warmer water animals.

So I figured through this temperature gradient, you would begin to see a transition from animals that are considered sensitive but also like cooler waters to animals that are a little more tolerant but seem to like and prefer warmer waters.

Q. Okay. What was the next step you took? And let's go to Joint Exhibit 77.

A. The next step was to deal with the issue of snapshot data because virtually all the data for the, you know, in the West

Virginia database and elsewhere have been snapshot data; and because we know from the ecology of aquatic invertebrates that it's not one measurement that's important, it's sort of the regime, I came up with a way of sort of representing what the seasonal pattern might look like for temperatures in waters that had different levels of conductivity in them.

And on this particular figure, it plots the -- those data represented by box -- what are called box and whisker plots for waters of different conductivity, and this particular figure also includes the temperature for Stillhouse. And I can walk through how this is constructed.

Q. So this is -- but before you do that, let's go back to the Joint Exhibit 77 and make sure I understand. You have these box and whisker plots, which in the middle is a dark line which is the median value of the data within that little oblong colored box, right?

A. Right. So to read a box and whisker plot, it's constructed of a couple of different parts. In the middle of the box is a horizontal line that represents what's known as the median value. And it's -- above and below that horizontal line in the middle of the box is where 50 percent -- in this case, 50 percent of the temperatures have been recorded for -- you know, in the West Virginia dataset I'm looking at here -- 50 percent of them would be higher than that median and 50 percent would be less.

Then there's the box itself. The top and the bottom of the box capture the central -- basically represent the center of the distribution of temperatures. So the bottom of the box, not the line that goes down, but the bottom of the box itself is at the 25th percentile.

So what that means is that 25 percent of the values are colder than that. And the top of the box is at the 75th percentile, which means that 75 percent of the temperatures are colder than that. In other words, 25 percent are warmer.

And then the line that comes out of each box and the little crosshatch on it, it represents the range of temperature.

Q. Again, these are out of the WV -- the DEP database.

A. These are from the West Virginia database. So these have been collected over many years and many days and many months. And this is a way of putting it all together so that this will be the first time probably this has been done. You can actually look at what the temperature distribution is of different waters.

So rather than looking at a single temperature, this gives a picture of what the temperature regime looks like for, say, low conductivity waters or waters with higher conductivity. You can visualize it and see it on this figure.

In those boxes can be hundreds of measurements taken, but they're all taken in June or July or August. But they could

be from different years. So that's --

Q. And different places as well.

A. And different places. They're what is in the database.

Q. All right. And then going to the next demonstrative slide here, can you explain how you constructed Joint Exhibit 77?

A. So the first thing I did was to kind of think about how temperature changes relative to two things, conductivity and -- let me take a closer look at it myself so I can see it. Yeah, basically temperature. I put on the two temperatures that I had referred to before at which I have some expectation that there would be a shift in the composition of the benthic fauna from cooler to warmer.

So one of those temperatures is 19 degrees. It's the horizontal line. And the other one is 21. So I started with that.

Q. All right. Next line?

A. And then from the entire -- you know, from the West Virginia database for headwaters, of all headwater streams similar to, like, Stillhouse, we extracted --

MR. LOVETT: Bob, I'm sorry. Is this a demonstrative --

MR. MCLUSKY: It's demonstrative. It's off of Joint 77.

THE WITNESS: So this would be a plot of all the low

conductivity waters that are in the dataset.

BY MR. MCLUSKY:

Q. This is all conductivities under 50 microsiemens?

A. Right, this is under 50 microsiemens. These are, again, box plots. And so from all the headwater streams for which we have data in West Virginia, if you extract temperature data throughout the year, plot it like this, this is what the pattern looks like. So, not surprisingly, it's cold in the winter, rises through the spring, tapers off in June, July, and August, and then descends through the fall and back down to the winter.

And all of those values for the low conductivity, the lowest conductivity, less than 50, are less than 19 degrees Centigrade. They kind of fall mostly below that line.

Q. Ready for the next one?

A. And then I plotted the reference stations. So basically these are the kind of data that are used by the state to make judgments about community composition and WVSCI for unaffected water bodies or mildly affected water bodies. These are the tier one reference stations that have been collected over the years by the State of West Virginia. And I've done the same exercise.

I plotted all those data for each month. So each of those box plots contains every bit of data for West Virginia headwaters that are collected at different locations,

different years, but distills it down to kind of a representative distribution of what temperatures are like in reference water bodies.

And so this is a really good baseline for judging departures from temperature. So if you were to compare water that might be warm, you could compare it to this baseline to see whether the water of that -- the temperature of that water body was different or not. So this is sort of the baseline for all the reference data.

THE COURT: And the dotted lines that run vertically from the boxes, that indicates the absolute range.

THE WITNESS: Right, that's the absolute range. And in this particular one, I know it's there, but I can't really see it on the screen from here. I know there's a little circle. You might see it above the month of --

BY MR. MCLUSKY:

Q. Actually, if you go to page 961, Dr. Menzie, you might be able to see those circles better.

A. Yeah. But basically if there's a value that seems to fall out of the distribution, the program for plotting these box plots will show a value that is considered to be an outlier. So you can see there's an outlier value. But essentially reference water bodies in West Virginia typically are less than about -- you know, the central temperatures or the median temperatures were all less than 20 degrees

Centigrade, even in the summer, and 75 percent of the values are less than about, you know, 19 -- as you can see, they're 19 degrees, and occasionally you get values that are higher. But that's an excellent baseline, then, for judging departure.

So you'd expect that animals that evolved over time in West Virginia streams would have experienced this temperature regime.

Q. And then your next box, I think, was conductivity over 300 microsiemens.

A. Right.

Q. That's shown on the next slide, I think.

A. So then from this dataset, I extracted the data for headwater streams that had conductivities in excess of 300 microsiemens to see whether those temperatures were different from the temperatures in reference water bodies. And as you can see, they're significantly different. They're higher. And that exists throughout the summer, that they're much higher than the temperatures you'll find in reference water bodies. This is everything from 300 up. But there are some months where they're similar.

So, for example, if you look at May or if we look here at -- yeah, if we look at May, you'll see that there's actually -- they may not be as dissimilar at some times of the year, but during the summer, these waters are significantly higher if you're greater than 300 microsiemens than if you're

a reference water body.

Q. And I've managed to put a yellow squiggly on the bottom of your exhibit, and I apologize.

All right. So, Dr. Menzie, before we put the Stillhouse data on, generally what does this tell us about what you see in increasing conductivity in waters?

A. Well, there's a couple of things you can see here. One is that, as I just mentioned, the waters are significantly higher in temperature than are the reference water bodies.

Q. How did you bin -- you've grouped these data. So you've got reference and low conductivity, and I think I generally understand that. And then you have conductivity over 300.

How did you choose the bins of data here?

A. Well, in this examination, recognizing again that they're all snapshot data that I'm kind of pulling together, I chose to use the benchmark value as a basis for separating values or waters that were warmer than or had higher conductivities than the benchmark as compared to the reference water body set.

So I used that as a basis of binning. So it's got all the values that are greater than 300.

And the thing I was looking for here was to see whether, one, they were significantly different. They are. But you'll also notice that these temperatures are well below the temperature value of, like, around 30 degrees that has been called out by EPA and others as being sort of the cutoff for

reference water bodies. There's no reference water bodies that come close to that.

And if we believe in the idea behind evolution of benthic communities, insect communities, with respect to the streams that they live in, the blue would indicate where you would have communities that are reflective of streams that are in the headwaters of these West Virginia mountains, while the yellows depart from that. They push up. And they push up into and beyond the zone of what I would consider a transition zone between cooler water animals and warmer water animals. You'd expect a shift on the --

Q. And the shift from the sensitive species to tolerant species, what effect does that have on things like WVSCI scores?

A. Well, because the WVSCI score is based on a reference water set and departures from it, it would decrease the WVSCI score.

Q. You lumped all of the over 300 conductivity into the yellow bins. If you had re-binned that so it was 300 to 1000 and 1000 to 3000 and you'd broken it up more, would it have any substantial impact on the way the graph would appear to you now?

A. It might a little bit. All the -- the values would still be higher, but also I've noticed that the influence of temperature is very profound initially and then kind of tapers

out a bit for a variety of reasons so that you would see this kind of an effect, but you wouldn't see it linearly. It doesn't -- it's not linear.

Q. All right. Let's go ahead and lay the Stillhouse data on this to complete the Joint Exhibit 77.

What does this tell us about Stillhouse, both in terms of conductivities and its temperature with respect to all of the other sites you examined?

A. So one of the opinions I put forward was that the temperature in Stillhouse is such that I would expect warmer water organisms to be present, and the cooler warmer animals reflective of reference water bodies might not be.

Q. Let me just stop you for a minute. Stillhouse. The rest of these data are all snapshot data from the DEP database; is that correct?

A. That's correct.

Q. Stillhouse data, where does that come from and how much is there?

A. It's a number of years of monitoring. Measurements are made twice a month. So these are representative of the data in the water forming Stillhouse. And I received those data and created the box and whisker plots you see here.

So you see in the summer months, Stillhouse can get quite warm. It's not surprising because of a pond. There's a pond there. And any time you slow up water and remove trees and

vegetation, you're going to get hotter water. It's going to heat up. So you basically have that.

But the important thing with respect to my opinion was that those warmer waters are sufficiently warm to result in -- certainly be one of the key factors in influencing the kinds of animals that you would expect to be present in waters at those temperatures.

Q. And to make sure I understand, based solely on the places where insects live as measured in the DEP database, you would expect here to find a tolerant type of community -- is that a fair statement? -- at Stillhouse?

A. That's correct.

Q. And what effect would that have on a WVSCI score at Stillhouse?

A. Again, because WVSCI scores are departures from the blue, the cool waters, I would expect the WVSCI score to go down.

Q. So you see a general shift from sensitive to tolerant bugs somewhere between 19 and 21 or 22 degrees C. Is that a fair statement?

A. There's a shift that goes through here. The precision of this is obviously influenced by snapshot data and all the rest, but this is what is -- you know, there's no question that the yellow bars are significantly above the blue; basically elevated conductivity is higher than reference areas. And Stillhouse is above that in terms of temperature.

Q. All right. Anything else this tells us?
A. I think it's important to understand the seasonal pattern of temperature before making conclusions about the influence of temperature on biota.
Q. Okay. Mr. Tyree, would you turn to Joint Exhibit 58, page 493, which I think is table B-20 of the benchmark.
Dr. Menzie, I don't know if you can see that, but I want to point your attention to paragraph 5. Can you read that?
A. Yes, I can read that.
Q. What does EPA -- this is a paragraph in which EPA -- why don't you blow that up just a little.
See, EPA gives a minus. Why don't you go ahead and tell us what they say here about -- this is a table in which EPA determines that temperature is not a confounding factor in the benchmark; is that correct?
A. Yeah. You know, I think this is really critical because this piece of information has been carried through so many things. But basically this says temperature limits are highly taxon-specific, but temperatures rarely exceeded the West Virginia limits for reference sites, which is you have to be less than 30 degrees Centigrade during -- basically during the summer or from spring to fall.
And what struck me about that is, first of all, I have no idea where that number came from, but it's being used to say, well, if temperatures are less than that, things are probably

like reference water bodies. But, you know, as I've shown already, reference water bodies are generally less than 20 degrees Centigrade, 10 degrees less than this number.

Q. So to the extent this is a statement that the non-reference data is not confounded by temperature, it's based on a mischaracterization of what reference streams actually show. Is that a fair statement?

A. Right. I think -- I have no idea where that value came from, but it would not be a value that would be reflective of what a reference water body in headwaters would be in West Virginia.

Q. Is it your belief that temperatures have to reach a lethal range to show a shift from sensitive to tolerant bugs, or does the DEP database itself show that that occurs at levels below those that would be deemed lethal to even sensitive insects?

A. Yeah. The work that I've done, at least for West Virginia waters, shows that those shifts are occurring. And based on my experience going back to the '70s to the present on the effects of temperature, you don't have to kill things to have them not be there. Basically they -- so many things are affected by temperature, including reproduction and choice, you know, whether you want to be in that kind of water or not, you know, such that you expect to see warm water communities, cooler water communities, and that's a reflection

of the temperature. It doesn't have to kill them.

Q. If we had not had the measured temperature at Stillhouse over time, do you have some sense of what a single snapshot might have revealed to us or not revealed to us about Stillhouse, and do you have a demonstrative slide to show that?

A. I do, but I would also say that as an ecologist, I would have been suspicious or expected -- expecting that temperature could be important just by the physical layout of the system, recognizing that the role of ponds have in warming waters.

So I would have already had a priori knowledge that temperature is likely to be an important factor.

Q. Right. And I think the point of the demonstrative slide is just to show what happens with snapshot data generally if it's misused.

A. Okay.

Q. Go ahead. Explain to us the first demonstrative exhibit here, what it is.

A. So this is a measurement that plaintiffs produced for Stillhouse.

Q. What does it show?

A. It's a temperature of about 18 degrees Centigrade collected on September 30th. And it was the extent of information that they had at the time about temperature. But as I've shown you from the data already, this tells you very

little about Stillhouse.

Q. All right. Do you have another demonstrative slide?

A. This is the temperature. It's a little lower. This is the temperature in April from Stillhouse. Those are two different temperatures. Had you only that one piece of information, either the September 30th number or the 18 degrees or this number and you were asked to say something about the role of temperature in Stillhouse, you really wouldn't have much to say I don't think.

Q. So do you have a slide that demonstrates that here?

A. Yes. So this is the temperature in Stillhouse. And you can see on here the one measurement that the plaintiffs' expert made and concluded was normal and then a value from April.

So you really can't say anything much about temperature in a water body without understanding something like this or at least having some a priori knowledge about how temperature might be influenced by physical conditions.

Q. Let's go to Joint Exhibit 74, if we could.

Doctor, we have Joint Exhibit 74 up on the screen. Can you tell us what this is or what it tells us in addition to the information you've already imparted?

A. This is a bit separate from what we've talked about, but I was aware that the extirpation of sensitive benthic species with regard to conductivity was occurring between low

conductivities and 300. So by the time you get to around 300, whether you're looking at EPA or you're looking at, you know, the work that Bernhardt et al. did, you've lost species and genera.

So the question was, is that a range of conductivity through which you might also be losing genera based on temperature. And that's what this exercise is. So I looked separately at June, July, and August for the West Virginia headwater data and plotted the low conductivity water. That's basically all waters that are less than a hundred.

Q. And that's in the aquamarine or blue?

A. Those are in aquamarine.

Q. Right.

A. Conductivity waters between two -- let's see, 100 and 200 in yellow, and then conductivity waters being between 200 and 300. And I plotted that for those three months. And, again, these are snapshot data that have been brought together to see whether there's a pattern, whether there's a possibility that as temperature would change through this regime along with conductivity, you might have been -- that might have been bringing about a shift in the animals, you were losing animals that were restricted to cool water as you increase the temperature and simultaneously the conductivity. So both those things were going on.

And what that shows is that those two things happen at

the same time; and, again, that's not something that should be surprising because both temperature and salts in the water are responding to the change in the landscape.

Q. So to summarize what you see is that as the conductivity shifts from two to three hundred to the benchmark value, you're also passing through your normal change zone from a sensitive to a tolerant species?

A. Correct. You could be losing species here either due to conductivity or due to temperature.

Q. All right. And, again, why do you choose the summer data here?

A. They provide us with a period of the year when conditions might be most restrictive for the types of animals that can live there.

Q. Okay. Were you here for Dr. Kuehn's -- or Carrie Kuehn's direct examination?

A. Yes.

Q. Okay. Did you hear her suggest that Dr. King, when he tried to run a regression line, I think it was called, through all of the temperature data in the DEP database, shouldn't have truncated the data or cut it into just the summer months?

A. Yeah. I think we're addressing different types of questions.

Q. Explain that to me.

A. So I'm looking at a period of the year where we can

derive temperature data for the animals that might be stressful to them, that might be restrictive. We couldn't see this in the spring or the fall because of the varying and changing temperature. But we can presume that it exists, you know, in the summer. And so I've chosen summer to kind of, in my analysis, to kind of look at whether temperature and/or conductivity might be affecting animals in the summer and that they might be changing together in the summer. So that is why I chose summer to be the basis for examination.

If, on the other hand, you were looking at whether, over the course of the year, whether conductivity is related to temperature for a variety of factors, then the analysis that EPA would -- did would be the proper analysis just to kind of take a look at that.

Q. Okay. So is it fair to say what you did -- the EPA database is a snapshot database that really doesn't tell you much about individual sites. Is that a fair statement?

A. That's correct.

Q. What you tried to do was to organize the data in different ways to see if we could find some patterns in the data that hadn't been examined by EPA.

A. Right. Don't rely on a single value. Almost all of the plots that I've seen are all snapshot data. And given the variability that there can be in temperature on any one day, the value put on a figure could be 10 degrees different from

that, as we've heard.

So looking at that snapshot data in a regression or a correlation introduces an enormous amount of uncertainty so that you really shouldn't, I don't think, rely upon that.

So what I did that's different than, you know, kind of relying on the snapshot data directly as indicative of what is there, is I kind of pool those data into bins so you can kind of see these patterns without relying on any one value.

Q. Did the DEP do this at all in its benchmark?

A. No, but I've shared this information with them. So --

Q. Recently?

A. Recently.

Q. Now, without doing this kind of analysis, do you believe that EPA properly discounted temperature as either a confounding factor or a cause of WVSCI scores at locations where temperature exceeds 21 or 22 C?

A. I think they did improperly discount it. I am guessing from having, you know, worked with them a little bit before, they may not have recognized it. They just may not have seen this or understood.

Q. There's no evidence in the benchmark that anyone organized or reviewed the data in this way, is there?

A. No.

Q. Based on your review of the temperatures and the animals living as compiled in the DEP database, what would you expect

the WVSCI -- to happen to WVSCI scores in Stillhouse with the temperatures you saw in Joint Exhibit 77 I think it was?

A. Well, they will be, you know, certainly lower. They will be lower. And based on my examination of the conditions, you know, temperature and others, I think that the probability is that they would be below 68.

Q. Okay. Do you believe your analysis proves that temperature is the sole cause of impairment at Stillhouse?

A. No.

Q. Okay. What does it prove, then?

A. What it shows is that temperature is playing a potentially important role here. My personal belief on all this is that all of these are bundled together and so that -- and we can call that confounding. So that things that are being attributed to conductivity may be related to temperature, that because of the uneven quality of the data, these things can't easily be teased apart with what we have to work with.

So for that reason, these can't serve as a proof. All that can be said is that, you know, the evidence is that based on what I've demonstrated here and our a priori knowledge of the importance of temperature, that temperature certainly could be a factor that leads to lowered WVSCI scores immediately below the pond.

Q. Do you believe that the plaintiffs have adequately ruled

out temperature as the causal factor for impairment in Stillhouse?

A. I don't think that -- personally I don't think that the plaintiffs seriously have considered it, you know, as a causal factor.

Q. But based solely on the DEP database that would suggest that there -- you would not expect there to be sensitive taxa in Stillhouse based solely on the distribution of the insects by temperature in the DEP database.

A. That's correct.

Q. Let's turn to habitat, if we could for a moment, then. How is habitat accounted for in the DEP database used in the benchmark?

A. The DEP database relies on a number, a numerical value, that's derived using something called the rapid bioassessment protocol.

Q. That's the RBP we've heard about before?

A. Right. Those are generally referred to as RBP scores.

Q. Okay. Can you tell us a little bit about the RBP and how the number is derived?

A. Well, the idea behind the RBP was to allow a biologist or environmental, you know, technician basically to visit a stream for the purpose of collecting bugs and make some measurements, but also to observe what the conditions were like at that stream that might be relevant to thinking about

the habitat.

So these are things that can be easily seen, like what do the banks look like, whether the substrate has some silt or cover on it, whether there's vegetation next to the bank, things that, you know, somebody can record easily in a book.

Q. Is it a multi-metric scoring system, essentially?

A. Well, what it is, is it's 10 separate types of observations about the stream, sort of the physical features of the stream, each of which is given a number from zero to 20. And then the number itself, the RBP, is tabulated by adding those 10 numbers together.

Q. So it's an aggregate score of --

A. It's an aggregate score.

Q. -- 10 different metrics?

A. Right.

Q. Okay. Does that suffer -- is that causing limitations in the ability of the RBP to discern impacts on -- or to properly characterize the potential impacts on macroinvertebrates?

A. It is really a very rough measure. It gives a sense of the general quality of the habitat in the immediate area, things that might be important to be aware of. As an ecologist, you would look at that and you'd say, you know, well, we have vegetation, we don't have embeddedness, you know, certain things that may be important, but there's a couple of things about it that are limiting.

One is that it's presuming that there's not other stuff going on that could be important from a habitat point of view. So it's restricted to a spot. So you go to a spot or a short stretch and you make some observations, but it's almost as if you put blinders on with respect to anything else that's going on.

So it's very useful I think for getting a gauge for the general condition, but it's not diagnostic of habitat.

Q. So it addresses a relatively short reach of the stream and a relatively narrow width outside of the stream bank?

A. That's correct.

Q. Let's put up -- I think it's Defendant's 37, which is the DEP assessment form for Stillhouse.

If you'd blow that up a little bit, Mr. Tyree.

I think we established yesterday, Dr. Menzie, this is actually the RBP form that DEP used at one of its site inspections at Stillhouse; is that correct?

A. That's correct.

Q. I just want to use an example. I see the first criterion is epifaunal substrate and available fish cover. Do you see that?

A. Yes.

Q. And then I think you said there's a scoring system under there of zero to 20, I think; is that correct?

A. Right, from -- to the right is the lower scores and to

the left is the higher scores.
Q. All right. And then someone actually goes out in the field and looks at the habitat and then rates it zero to 20; is that correct?
A. That's correct.
Q. Is there a certain level of subjectivity in the rating?
A. Obviously, since this is just personal observation. There's no quantitative measurements really.
Q. And then is it fair to say that what we end up with is an aggregate score? That is, each of these 10 criterion have a score of zero to 20 or zero to some number, and then the total number -- if you'd scroll down, Mr. Tyree -- is added up. So we have in this case a 94?
A. That's correct.
Q. So it's an aggregate score. Does that pose any problems in the use of the data to glean whether the score is indicative of good or bad macroinvertebrate habitat?
A. Well, I think the -- you know, obviously the lower the score, low scores, you're moving in the direction of being poor; and high scores, you're moving in the direction where more things are better. But the score itself can be a bit unreliable for a variety of reasons.
Q. Let's look at -- well, let's use an example. Let's look at -- scroll back down, Mr. Tyree, to criteria number two, which I think is embeddedness. What was the score in May of

2012 that DEP gave for embeddedness?

A. It received a 2.

Q. Okay. And notes that there are metal hydroxides in places; is that correct?

A. That's correct.

Q. What type of impact can a high level of embeddedness or a poor embeddedness score cause to macroinvertebrates?

A. Well, this is something that would affect the habitat and change it away from a reference water body. So embeddedness can close up basically the homes for certain types of invertebrates by filling in the spaces in and around the rocks.

Q. Is it possible that with a low enough score in one of these criterions, such as embeddedness, that you might have a virtual elimination of the benthic community?

A. Well, that's very possible, and certainly you would eliminate all of the types of animals that would depend upon living in and around and under rocks if you've closed it off.

Q. So if I have a zero score in some of these criterion, I may end up with a severely impaired stream. Is that a fair statement?

A. Yes.

Q. And then if I scroll down, like criterion number 7, Mr. Tyree, I don't know if I can read that from here.

That's channel flow status?

A. Yes.
Q. And I think it's described here as -- the description of what it means is whether water reaches the banks, both banks of the stream.
A. Fills the banks. And, you know, Stillhouse is basically a discharge. So the water is just flowing out, and the banks are filled.
Q. And with respect to channel flow status, this rater gave the stream a fairly high score; is that correct?
A. That's correct.
Q. Now, you would add the 2 for embeddedness and the channel flow 18 score to get the 20 for those two criterion.

Do you believe that the 18, the high score of the channel flow status, raises or cancels out the impacts of a low embeddedness score?
A. No. They really are independent of one other.
Q. Okay. So that's an example of how an aggregate score here may not tell the whole story. Is that fair?
A. That's correct.

THE COURT: Let's take a -- we'll take a ten-minute recess.

You may step down. Don't discuss your testimony.

(Recess from 2:46 p.m. to 3:05 p.m.)

THE COURT: Doctor?

All right. Go ahead.

BY MR. MCLUSKY:

Q. Dr. Menzie, you were talking about the RBP score and Defendant's Exhibit 37, which is the May 2012 DEP RBP or site evaluation for Stillhouse. Do you recall that?

A. Yes, I do.

Q. Mr. Tyree, would you turn to page 1070 of Defendant's Exhibit 37.

I think we established yesterday, Dr. Menzie -- do you have a copy of that in front of you?

A. I do.

Q. -- that there's a -- on the DEP form, after the RBP score of 94 DEP gave this, there are a couple of additional criteria that DEP itself adds to the RBP form. Is that a fair statement?

A. Yes.

Q. Okay. And one of those is macroinvertebrate habitat?

A. Correct.

Q. And DEP gave it what score here?

A. A 2.

Q. Okay. Does that suggest to you the point you made earlier is accurate, that you might have a high epifaunal substrate or a high riffle pool score or high flow score, but none of that will give you necessarily -- overcome a bad score in other areas? So you may have -- end up with a very low macroinvertebrate score.

A. Yes, that's possible. The DEP biologists in this case basically render an opinion as indicated, you know, in this particular score regarding habitat quality for the benthic macroinvertebrates.

Q. What was that opinion?

A. It was poor.

Q. Notwithstanding the limitations in the RBP that you've talked about to discern impacts or to characterize an entire stream, we have at least the May 2012 RBP score from DEP for Stillhouse; is that correct?

A. That's correct.

Q. I think we established yesterday that that site is in the lower reaches of Stillhouse; is that correct?

A. That's correct.

Q. Okay. Are you aware of another RBP score that DEP has from 2003?

A. Yes. West Virginia DEP visited the site in 2003, calculated a score somewhere around 93, I think; 92, 93.

Q. Did Exponent also -- do you recall anything else about that site investigation from --

A. Much of the same kind of reporting, a highly modified substrate. At the time, they were -- the DEP biologist that was making a record of conditions noted a lot of deposits, things being stirred up, which I believe they may have thought were manganese precipitates.

Q. Black deposits?
A. Black materials.
Q. Did Exponent, your company, conduct at least some site investigation on Stillhouse?
A. We did, and our two biologists were much the same in that particular stretch of Stillhouse as reported out by the DEP.
Q. Now, did your biologists look at the entire segment of Stillhouse, the entire reach?
A. No. We were apparently -- and DEP too -- were looking for a reach that was sort of representative of a stream reach where you could do this kind of an assessment. And both DEP and our scientists went to the lower reach as being representative of that.
Q. Mr. Tyree, would you show Joint Exhibit 76 so we can just confirm those locations.

Dr. Menzie, looking at Joint Exhibit 76 on the screen, can you kind of tell us -- we probably already heard this yesterday, but where you believe DEP conducted its RBP and WVSCI scoring and where you looked?
A. Your Honor, where you see the reach that refers to Exponent, reach where Exponent conducted, sort of in the bottom-most part of the slide, that would be the same stretch where DEP went and did their investigation. It's immediately adjacent to the Twentymile, and there's a little culvert there through which Stillhouses passes and then drops into

Twentymile Creek.

Q. Do you know -- and you heard Dr. Palmer's testimony, I think yesterday, didn't you?

A. Yes, I did.

Q. Do you know where Dr. Swan did his site investigation?

A. As I understand from that testimony, Dr. Swan worked the stretch of stream that was immediately below the spillway. So you have this steep, wide spillway where the pond water is coming down, and then there's a very small stretch of stream between the base of that spillway and down to where that road is and that first culvert. It's in there that Dr. Swan made his observations.

Q. And that's shown by a little window saying Approximate Area Where Swan Sampled --

A. That's correct, yeah.

Q. Have you or your people walked the entire length of Stillhouse, though?

A. Yes.

Q. Do you know what RBP score Dr. Swan got when he did his investigation upstream of the place both you and DEP investigated?

A. He got a 130.

Q. And what does that tell you about the ability of the RBP to characterize the entire stream, if it's an accurate score?

A. Well, it shows that, from my point of view anyway, sort

of by-the-numbers kind of scoring at a spot can give a number like that that might not really reflect anything else that's going on in the watershed.

Q. And even if his RBP score was one we would all agree on, is it fair to say that Stillhouse flows from wherever he sampled into an area where both you -- that is, Exponent -- and DEP sampled and found much lower RBP scores?

A. That's correct.

Q. Do you recall any negative aspects of the Stillhouse stream that were found by Dr. Swan?

A. Dr. Swan found -- well, he found some positive things, which is it continues to flow and fill the banks, which is, basically, is a discharge. So it gets high scores for that. And then he found poor to marginal conditions for stream bank stability and for the presence of vegetation along the edge of the stream.

Q. Okay. And also notwithstanding the limitations of the RBP, did you attempt to take the categories of the RBP -- that is, the optimal, the marginal, whatever those ranges are -- and plot them over a range of conductivities to see what type of patterns you could see in the DEP database?

A. Yeah, I did that. I did that analysis.

Q. Okay. Why don't you explain to us what you did.

And let's put up Joint Exhibit 75, if we could.

A. Well, basically I did an analysis to help answer the

question whether habitat made a difference regardless of conductivity. And so I looked at small streams, smaller streams in the database. These are ones that would be basically no wider than 10 meters or 30 feet or so; so, you know, thinking in terms of Stillhouse as a smaller stream.

And I extracted from the -- for all these small streams the WVSCI scores and the characterization of the habitat as provided by DEP. And then what I did was for three sets of data, the entire database that West Virginia has, the database for the small streams in the middle, and then for the data that Emily Bernhardt and co-workers utilized for their "How Many Mountains" report, I looked at the comparison of WVSCI scores for habitats that were marginal or poor, basically kind of a degraded habitat by those metrics, as compared to optimal habitat.

And what I wanted to do here was to see whether, if you had an optimal habitat, whether that would give you basically a higher, what we call maybe a passing WVSCI score, even if you were exceeding the benchmark of 300, and whether you had a -- if you had a marginal habitat, you would be below, even if you were less than 300. So that was the idea behind this particular comparison.

Q. And this is a little busy I know. Do you have some demonstrative exhibits to explain how you put this thing together?

A. I do.
Q. Okay. Do you want us to walk through those?
A. So, again, we have these three datasets. The West Virginia dataset is going to be in the left-most panel, all the small streams in the West Virginia database in the middle panel, and then the Bernhardt et al. data that, you know, King and others have been co-authors of in the third panel.
Q. All right. And before we go on, now, all the records -- you didn't screen the DEP data for those sites that had non-alkaline drainage, that is, acid mine drainage or a chlorides-based discharge, did you?
A. No.
Q. Are there a lot of those in the database?
A. There are just a few, relative to the entire database.
Q. All right. And you didn't screen those out of the less-than-10-meter-wide stream category either?
A. Right.
Q. But to the extent they were screened, they -- you said they were screened in "How Many Mountains." They're screened in your exhibit as well; is that correct?
A. Right. So the Bernhardt data on the far left would be sort of exactly the same dataset, you know, with all the screening that went into that, which is a lot more screening than has gone into other datasets.
Q. All right. And so to make sure I'm clear on the record,

the Bernhardt data is the data that was screened from the DEP database to compile the paper "How Many Mountains Can We Mine?"

A. That's correct.

Q. Okay. All right.

A. So the first thing, what this shows is if we just look at optimal habitats and ask the question, if you have an optimal habitat, what kind of WVSCI score can you expect?

And so plotted horizontally are the two bars that represent numbers that have been talked about for judging WVSCI scores. So there's the 68. That's a solid line. And there's a number that's a little above 60. That's a dashed line because --

Q. That's the 60.6, the gray zone area we talked about?

A. That's the gray zone that's sometimes referred to. And then what you're seeing here are all the WVSCI scores for optimal habitats that fall into these particular categories. And what you'll notice is that -- let me look at the screen here.

For all these categories, the -- and, again, this is a box and whisker plot. So you've got the 50th percentile with that horizontal bar in the middle of the box. Then you've got the lower 25th percentile at the bottom of the box. And the 75th percentile is at the top. And then you've got what look like little cross bars that come up and down

there that are the ranges.

But the median values for all of these are greater than 68, you know, which indicates that greater than 50 percent of the observations that have optimal habitat are going to have a passing WVSCI score. And that --

THE COURT: I'm sorry to interrupt you, but I just want to make sure I understand you before you get off of this.

So the green box, the top of the green box is the 75th percentile, the bottom is the 25th.

THE WITNESS: Right.

THE COURT: The two vertical lines with the horizontal endings represent the range.

THE WITNESS: Exactly.

THE COURT: Then what are all the little --

THE WITNESS: Okay.

THE COURT: Are those that somehow fell outside the range?

THE WITNESS: They are referred to as outlier values. They're sometimes -- in these programs, there are data points that are, by the algorithm that's used to generate it, are judged to be outliers. And so they're kind of shown as, you know, as points.

BY MR. MCLUSKY:

Q. They're real data, though, are they not?

A. Yes, they're real data. Those are pure values there.

THE COURT: Just guessing, it looks like in the All Records column that we're talking about, that there might be 15 to 20 of these so-called outliers.

THE WITNESS: Sure. That's right.

THE COURT: I assume, then, they're characterized as outliers because even if there are 20 of them, they are such a small portion of the overall sample -- in this case, this overall sample of optimal habitat sites -- that it would somehow skew the range to include them?

THE WITNESS: Well, it would definitely bring the range down. So, Your Honor, if you want to think about where the range -- the absolute range is, you could drop that cross bar down. There's a couple of thousand values sort of in there. But, you know, that would be another way of thinking about it.

THE COURT: All right. So basically the 20 are considered such a small portion that you eliminate them from what might be otherwise a misleading statement of the range of value.

THE WITNESS: That's one way to look at it. It's definitely a statistical representation; and as individuals, we could say, well, I think those are important, and they can get as low as that because we've seen evidence that it can get as low as that, but the statistics of it in terms of the population of the sample kind of use those as outliers either

high or low.

THE COURT: Here, I guess if it's about 2000 samples and there are about 20 of these outliers, it's about 1 percent.

THE WITNESS: Something like that.

THE COURT: So this would be the bottom 1 percent of the optimal habitat findings.

THE WITNESS: That's correct.

BY MR. MCLUSKY:

Q. Is there anything else to this slide, Dr. Menzie, or do you want to move to the next one?

A. Just generally, just to recap, I had, you know, looked at this in terms of values, optimal values, if you have conductivities greater than 300, but optimal habitat you have a better than 50/50 if you're going to have a WVSCI score that's greater than 68. And then we can add in in comparison the marginal and poor habitat.

If you've got that kind of habitat, obviously the WVSCI scores go down. That's obvious right away. So at first glance at this, you know, habitat makes a difference obviously. But what I was looking for here was to see whether, if you in the face of having marginal or poor habitat, if you were able to have areas that had conductivities less than 300, which is the benchmark --

Q. Right.

A. -- would you expect a WVSCI score to be elevated. If the conductivity was low but the habitat --

Q. And remind me, the RBP scores that DEP got in the lower end of Stillhouse were characterized as marginal?

A. Marginal.

Q. Okay.

A. So what this tells us is that if we look at the Bernhardt data, for example, if you've got a value that is less than 300 but you have marginal or poor habitat, you're more likely than not to have a WVSCI score that's less than 68 rather than greater than 68.

So I felt it was important, rather than to speculate about that, to kind of look at the database and see what it tells us if we're thinking about the possible role of habitat in influencing WVSCI at Stillhouse. And you see that for the small stream dataset in the middle. And, of course, you see that for the complete dataset on the far left.

Q. Generally you see the same pattern across all three datasets?

A. Yes, same pattern.

Q. A couple of questions. Again, Stillhouse in the section that your people looked at and DEP evaluated had a marginal score, which is reflected -- is lumped in with the poor on your blue box; is that correct?

A. That's correct.

Q. Are there many poor scores in the database?
A. No. Looked at these with and without poor scores. There's very few.
Q. If you pulled the poor out and just put the marginal in, does it substantially influence the location of the blue bars?
A. No. It will look like this.
Q. And then Dr. Swan's score of 130, as I recall, puts it into the suboptimal category, which is between optimal and marginal; is that correct?
A. That is correct.
Q. And you didn't plot the suboptimal data on Joint Exhibit 75.
A. No, I didn't.
Q. Because you were plotting the score of the site that was actually measured by DEP and examined by your folks; is that correct?
A. That's what I knew at the time I -- you know, basically as I went into this, correct.
Q. All right. Now, if you were to take the suboptimal data and either put them into the optimal category or even the lower blue bar -- if you put them in the green bar instead of the optimal category, what effect would have that on the chart? Do you know?
A. Well, it moves these around. If you want to treat one category as if it was the other, it will move things up and

down. I chose not to do that for two reasons. One was that, you know, I knew the stream could really be marginal. I knew that there were a lot of other conditions, you know, in the watershed around the stream that influenced it, so that I felt, you know, marginal was very representative for Stillhouse. But also the purpose of this was to really point out that habitat can make a difference.

And I had done a close examination of the RBP scores and came to know that there's literally dozens, if not hundreds, of ways of producing the same score, so that the score itself begins to lose meaning. And what I wanted to show here was that if you have a lot of things that are going well for you in the habitat and a number of things that are not going so well for you in the habitat, does that make a difference?

So we don't really know for the area that Swan looked at what might be the most important thing that might be affecting benthic invertebrates. We have a number of things on the table. So in the face of that, I did a comparison like that to see whether -- just to answer the question whether habitat makes a difference.

Q. Okay. And, again, what we see then on Exhibit 75 is that across all of the three different categories of data here, if you were to reduce conductivity to 300, at least the database would suggest that you still would not achieve a passing WVSCI score if you are in a marginal habitat; is that correct?

A. You definitely cannot conclude that that would occur. It doesn't mean that it's impossible, but you shouldn't have an opinion that that's what's going to occur, or an expectation.

Q. We started off with a short discussion of how much is Stillhouse like a reference stream, and I think you said not much.

Let's -- Mr. Tyree, if you could put Joint Exhibit 37 back up.

Let's go to the first page of that, which I think is page 1064. That's the drawing. Let's blow that up if we can.

And there was a little confusion I think at the end of some of the testimony yesterday, but I'll see if I can't clarify this.

Looking at the drawing, Twentymile Creek is somewhere off to the left but off of this drawing. Is that a fair statement?

A. That is correct.

Q. And at its terminus, as you said earlier, Stillhouse falls through a culvert into Twentymile Creek; is that correct?

A. That's right. I waded that area. And when you walk down Stillhouse, you have to, like, slide over a bank and drop down into Twentymile. And then as you walk in Twentymile, which maybe is a foot or so deep there, you come to this culvert, which is basically what Stillhouse flows into, flows through,

and then it drops -- the water drops into Twentymile. So the whole system is basically engineered.

Q. That's off of the drawing before you.

A. Well, that would be off to the left.

Q. Right. So we're moving upstream as we move from left to right.

A. Yes. Yes, that's correct.

Q. And that's denoted -- I think if you look on the left, you'll see a "DS," which I presume means downstream.

Do you see that along the left margin, midway?

A. Right.

Q. Then on the far right of the paper, you'll see a "US," which I assume means upstream.

A. That's correct.

Q. And the ponds that we see pictures of below the valley fill would be off this picture to the right.

A. They would be off to our right.

Q. Okay. And then as we walk through at least this part shown on Exhibit 37 of Stillhouse, starting on the left we see a culvert -- road and then a culvert. We see a steep eroding bank. Is that fair?

A. Yes.

Q. Okay. What effect does that have, if any, on the habitat for macroinvertebrates in the stream?

A. Well, it tells us a couple of things. One is that, you

know, there have been events that have sort of been sufficient enough to kind of erode and work into this bank, but also the soil that was part of that bank probably is, you know, depositing into the creek.

Q. And we have erosion on the other side of the creek as we go upstream next to old stump. Do you see that?

A. Yes.

Q. And then coming further upstream, we have another undercut bank and a culvert and then, it appears, railroad tracks; is that correct?

A. That's correct.

Q. And then we go through another -- you see power lines, another road and culvert, and then eventually we come up to the flume we saw yesterday?

A. Yeah. I don't think the flume is on --

Q. Right.

A. -- this particular map.

Q. Right. Describe the water coming off that flume that you saw.

A. Well, it's kind of like a raceway. So you have water that tops over the pond and flows rapidly down the flume, and the flume is concrete so that it, you know, transmits that water into the rest of Stillhouse.

Q. Let's go to page 1066, if we could, Mr. Tyree.

I think we went through with Dr. Palmer yesterday there

is in the top box here a -- where it says Rate Sediment Deposits, do you see that box?

May I approach, Your Honor?

THE COURT: You may.

THE WITNESS: Yeah, I see that.

BY MR. MCLUSKY:

Q. And on this form next to that, there's a rating system of zero to 4, from none to extreme, for sediment; is that correct?

A. Yes.

Q. And then there is also a 4 to the next of that which presumably describes the nature of that sediment. Do you see that?

A. Yes, I do.

Q. What does it say?

A. Manganese, black hydroxide.

Q. Okay. So do you read this to say that the sediment that's present is dirt or that it's manganese hydroxide type of materials?

A. Well, there are -- you know, in terms of the sediment that -- this deposited sediment that the DEP saw down there, they're characterizing it as manganese hydroxide.

Q. I'm sure the plaintiffs will ask you this, but manganese hydroxide you would not expect in a reference stream, would you?

A. No.
Q. Okay. Manganese hydroxide is a product of what, if you know?
A. This particular mine during its operation, and I guess through 2012 anyway, has a requirement to treat for manganese when manganese is evaluated, and they have various treatments, and those treatments contain -- create -- can create a precipitate. And that precipitate, while mostly is supposed to settle in a pond, some of it can be carried over and become deposited.
Q. And that resulted in the conditions DEP found in 2012. Is that fair?
A. That's fair.
Q. And were those conditions noted also in 2003, I think, as well? Is that correct?
A. Right. That's been -- during the operation, yeah.
Q. All right. Are the types of the severe deposits of manganese hydroxide, are those the kind of things that could cause an impaired WVSCI score?
A. Certainly.
Q. Did Drs. Palmer or Swan or King ever visit this part of the stream?
A. In re-reading Dr. Swan's, he may have walked along a little bit. It says he was, like, looking around for where he could sample. So he might have looked at this a little bit,

but otherwise, no. I know that Dr. Palmer visited the place where Drs. Swan and Hansen were sampling, but Dr. King did not visit the site.

Q. So their conclusions were reached without ever seeing the area that DEP actually evaluated in its TMDL assessment; is that correct?

A. I don't think any of them, including Dr. Swan, went into the water here.

Q. Okay. Is it conductivity that precipitates out of the water column or is it a particular substance that precipitates out of it?

A. It's a substance.

Q. Okay. Do you believe that an adequate specific causal assessment could be done without visiting the area that DEP actually assessed here?

A. No. I think you would have to do the work necessary, you know, including visiting, seeing, measuring, to do a proper causal assessment.

Q. Okay. I want to go back and clean up a few things I may have missed.

Pond 2014 -- and I may be confused on my Pond articles, there have been so many; but one of them that we confirmed, he had temperature data, but it was only from April at a number of sites, but it was all the same month. Is that a fair characterization?

A. I think that's correct. I think any of these references to not seeing differences with temperature and referring to Pond are incorrect in terms of making an assessment because Pond only sampled and did these kinds of comparisons based on April and/or May, somewhere in there.

Q. And in the 2004 Pond article that was testified to yesterday, I believe we confirmed -- I think it was table 4 -- that there was a relatively high correlation between the percent forest and changes in benthic macroinvertebrates. Is that fair?

A. That's correct.

Q. And that the unmined sites had a higher percent of forest than the mined sites. Is that fair as well?

A. That's one of the most distinctive differences between mined and unmined sites.

Q. How did Pond account for the differences between the mined and the unmined sites in terms of the percent forest and the potential -- its correlation with macroinvertebrate scores?

A. Well, he recognized that it existed, that it was an important factor, but then he stepped away from that and looked only at the mined sites.

Q. So he looked, in terms of trying to discriminate on landscape effects on insects, he tried to discriminate between the mined sites but not between the mined and the unmined

sites. Is that fair?
A. That's correct.
Q. There's been talk about multiple lines of evidence. Don't the benchmark and the "How Many Mountains Can We Mine" articles rely on subsets of the same database?
A. Those two pieces of work rely on the West Virginia database that we've discussed so far. So they're largely based on that.
Q. And I think we established yesterday, reading various abstracts into the record, that none of the Pond articles that I recall make the claim that conductivity is causing any particular effect.
MR. LOVETT: Objection, Your Honor. This is not in his report, and it's not cited -- these articles are not cited in his report as articles he relied upon.
MR. MCLUSKY: Well, there was testimony about it yesterday, and much of this came up in their rebuttal reports that we had never -- that Dr. Menzie never had an opportunity to respond to. They chose --
MR. LOVETT: It's not in our rebuttal reports.
THE COURT: Wait a minute. Finish your statement.
MR. MCLUSKY: Much of this I believe was listed in the rebuttal reports. You may recall that I raised there are 11 listed in the initial report. Mr. Lovett's response was much of it is in the rebuttal report. We did not object to

letting them put a rebuttal case on as part of their case in chief, but we have, I think, a right to respond to it.

MR. LOVETT: If he can point to the rebuttal report that we have citing the article that he is now relying on, that would be something that may be admissible.

THE COURT: Well --

MR. LOVETT: But, honestly, this is not something that this expert, we had any notice that he was ever going to testify about. It is not -- we didn't have the opportunity to examine him in deposition about it. It was not relied on by him. It's not listed in his references, and it wasn't part of his report.

MR. MCLUSKY: May I respond here? The Pond 2014 article was the one just revealed.

MR. LOVETT: I agree about the '14. I'm not objecting about the '14. You have the right to ask questions about that. But all the other Pond article, the only one that's cited in his report is Pond 2008.

MR. MCLUSKY: I'm finished along these lines, Your Honor.

THE COURT: You're finished? Move on, then.

MR. MCLUSKY: Mr. Tyree, could up put up -- I think we have a slide with Joint Exhibit 75 and 77 next to each other.

BY MR. MCLUSKY:

Q. Dr. Menzie, I've got up on the screen Joint Exhibit 75, which I believe is the review of the effect of habitat and suggests, at least in the data you looked at, that even with a low conductivity below 300 at a marginal site, the data suggests you would not get a passing WVSCI score; is that correct?

A. That's correct.

Q. And that's the category into which Stillhouse fits in the area that you and DEP looked at; is that correct?

A. That's right.

Q. And then on the right, we have the information about the temperature divided in the DEP database by conductivity; is that right?

A. That's right.

Q. And then we also have laid on that the Stillhouse temperature data; is that correct?

A. That is correct.

Q. And those data also suggest that with the temperatures at Stillhouse, the animals that you would expect to find at Stillhouse based solely on their distribution in the DEP database would be animals that are tolerant and not sensitive and could well or likely fail a WVSCI test; is that correct?

A. That's correct.

Q. Now, when you take those two together, do you believe

that the plaintiffs have adequately determined that Stillhouse's impairment there has been caused by conductivity and not these other factors?

A. As I understand the testimony of plaintiffs' experts, it is conductivity is the primary cause, I think is what I've heard, and that these things don't matter. And I -- my opinion differs with that because not only do we have marginal habitat, but we have elevated temperature, and there may be other aspects of the watershed that are modified.

I work in the field very much of cumulative risk assessment, thinking of multiple stressors, and these things don't act independently. They kind of combine together to kind of influence the nature of the organisms that are there, the community. And when I look at data like this where you've got elevated temperature, which happens because, naturally, the pond is there and it gets warm, and you've got marginal habitat, both of which we know will influence WVSCI scores in the community structure; when you have both of those together, I'm pretty certain that they will influence and control the WVSCI scores in Stillhouse.

Q. And at least according to the way the animals are distributed in the DEP database, you would not expect a passing WVSCI score at the site based on the temperature and habitat. Is that fair?

A. Based on the work that I've done so far in looking at

that database, that would be my expectation; I would not have an expectation of a passing WVSCI score.

Q. Even if the conductivity --

A. Even if the conductivity was brought down.

Q. And I think you also have said earlier that you believe these same types of factors were not adequately accounted for in the benchmark for the reasons you testified before, right?

A. That's correct.

MR. MCLUSKY: May I have just a moment, Your Honor?

THE COURT: You may.

THE WITNESS: Your Honor, may I ask for a short side break?

THE COURT: I think he's about to finish.

THE WITNESS: Okay. Good.

THE COURT: Are you about to finish? The witness would like a break.

MR. MCLUSKY: Oh, yeah. I have one clarifying question.

THE COURT: Go ahead and then we'll take a break.

BY MR. MCLUSKY:

Q. I was informed, Dr. Menzie, that one of us -- and probably me -- used the "mean" rather than "median." Is it fair that the horizontal lines in your box and whisker plots represent a median value rather than a mean value?

A. They do represent a median value.

Q. Median?

A. Median.

MR. MCLUSKY: Okay. Thank you.

THE COURT: All right. Let's take a ten-minute recess. You may step down.

(Recess from 3:42 p.m. to 3:52 p.m.)

THE COURT: All right.

MR. MCLUSKY: Your Honor, I did not want to wait until the end of trial because I'd never find my notes again. So I just wanted to, if I could, move the exhibits that I used.

THE COURT: Okay.

MR. MCLUSKY: And they would be Joint Exhibits 68, 70, 71 and 72, 73, 74, 75, 76 and 77, and Defendant's 6, which is the appendix E to Menzie's report, and then 37, which may already have been -- Defendant's 37 may have already been admitted. That's the DEP inspection sheet.

THE COURT: All right. Any objection?

MR. BECHER: No objection, Your Honor.

THE COURT: They're each admitted.

MR. BECHER: I've been asked to introduce the introduction of plaintiffs' exhibits from Dr. King.

THE COURT: All right.

MR. BECHER: These are all reports in plaintiffs' exhibits. They are studies that were read into evidence that

fall under learned treatises. So as we agreed, we're only introducing the portions that were actually read and provide copies to the court reporter of those sections. But those are Plaintiff's Exhibits 2, 5, 8, 10, and 12.

THE CLERK: I lost you.

THE COURT: 2, 5, 8, 12.

MR. BECHER: 2, 5, 8, 10, and 12.

THE COURT: Any objection?

MR. HARVEY: Not as long as it's subject to the earlier understanding, Your Honor.

THE COURT: And that is that they're just excerpts of learned treatises?

MR. HARVEY: For the court reporter's purposes. And, Your Honor, as long as I'm on my feet, we would like to also admit Defendant's Exhibit 1 from --

THE COURT: CV?

MR. HARVEY: CV from Miss Kuehn. I'm sorry. It was the diagram from Miss Kuehn's testimony, the C, the E, and the Y.

THE COURT: Any objection to --

MR. BECHER: Just to clarify, there were a couple of triangles. Some were demonstrative exhibits and some were -- one was from her report. We're only talking about the one from her report?

MR. HARVEY: Yes.

MR. BECHER: No objection.

THE COURT: All right. It's admitted.

All right.

CROSS EXAMINATION

BY MR. LOVETT:

Q. Good afternoon, Dr. Menzie.

A. Good afternoon.

Q. You were testifying about the RBP, I think, that DEP took and that Dr. Swan took. Do you remember that?

A. Yes.

Q. Now, Dr. Swan did his RBP on Stillhouse, just in a different spot from the DEP, right?

A. Correct.

Q. I think he did it upstream closer to the pond and to the mine, right?

A. Yes.

Q. You're not saying, are you, that that portion of the stream doesn't comply with what Dr. Swan found, are you?

A. Can you --

Q. The portion of the stream that Dr. Swan performed the RBP on, you're not testifying that his RBP is not accurate for that portion of the stream, are you?

A. I'm not second-guessing him.

Q. You didn't perform an RBP yourself, correct?

A. Yes; I did not.

Q. Did somebody from Exponent or somebody from your shop perform an actual RBP?
A. Yes.
Q. Okay. And what was the score?
A. Well, what they reported out was something in the neighborhood of either 100 and/or 72. There were two values.
Q. Okay. You didn't bring that for testimony today?
A. No.
Q. It's not introduced into evidence, is it?
A. No.
Q. All right. Now, you say you had published approximately 50 papers in peer-reviewed journals over your career?
A. I think so.
Q. And do you find the peer-review process to be a rigorous method for validating scientific theories?
A. It is the process that we have, yes, and it should work well.
Q. Okay. In this case, the published data and the published theories regarding that data are very consistent, aren't they?
A. Can you be more explicit about that?
Q. Well, they all reach the conclusion that large-scale surface mining in Central Appalachia is raising conductivity significantly, don't they?
A. That would be the Bernhardt papers and the Pond papers, yes.

Q. Okay. There's no dispute about that in the published literature, right?
A. That's correct.
Q. And you don't disagree with that either, do you?
A. No.
Q. Okay. So you agree with all those papers that say that conductivity is being raised because of surface mining in this region.
A. That's correct.
Q. And those papers also show that WVSCI scores below surface mines are, for want of a better word, very poor, aren't they?
A. There's different kind of scales for WVSCI scores. So do you have a number?
Q. Many of them are below 68, aren't they?
A. Yeah, below 68.
Q. Most of them, right?
A. I don't have that in my head, but, yes, many.
Q. How many have you looked at?
A. I've looked at the database, but what I'm telling you is that I don't have a numerical value of percentage.
Q. But it's true, isn't it, that many more than 50 percent are below the 68?
A. I don't have a percentage.
Q. And you don't disagree, do you, that the impairment below

large-scale surface mines is being caused by the mining?
A. I think mining is a contributor to lowering WVSCI scores in terms of modifying the streams.
Q. At Stillhouse you agree, don't you, that mining is the only reason that the WVSCI score is so low?
A. I think that's correct.
Q. And it's Fola's mine that is the reason for that, correct?
A. Yes.
Q. And you agree that the conductivity there is elevated usually over 3000, correct?
A. Yes.
Q. You agree that the sulfates there are over 2000, don't you --
A. Yes.
Q. -- for the most part? And you agree that it's an impaired stream.
A. Yes.
Q. And that it's impaired because of mining.
A. Yes.
Q. You just don't agree that the plaintiffs have shown that it's the conductivity and its associated ions that have caused that impairment, right?
A. That's correct.
Q. You don't have an opinion, though, do you, that the

temperature is the cause of that impairment?
A. That's correct.
Q. You don't have an opinion that it is the habitat that's causing it, right?
A. That's correct. I think all of these things contribute.
Q. Right. You think that -- and in your previous testimony, I think you said that when conductivity reaches the level of 2000, that you expect that to have a significant impact on an aquatic ecosystem in this region; is that right?
A. I don't think I said that.
Q. What did you say?
A. I think at a level of about 2000 is when you would begin to think about conductivity as having an effect upon biota.
Q. You wouldn't think about it before then?
A. With respect to my testimony at that time? That's what I said, and I was referring to the studies that had been present at the time, and I was talking not about WVSCI scores or stream conditions but when you might see effects.
Q. At what point now would you think about conductivity as a potential concern for impairment below valley fills?
A. I still have the same opinion.
Q. So in this case where you have a habitat score of either suboptimal or -- by our account, or marginal by your account --
A. Yes.

Q. -- and you have sulfates at 2000 and conductivity at 3000 and the temperature -- high temperature, the highest temperature point at approximately 24 degrees C, do you think it's a combination of those factors together that contribute to the impairment?

A. I think all of those factors, you know, may be involved.

Q. Okay.

A. But we haven't determined what their relative importance are.

Q. Okay. How many times have you been -- how many times have you been hired as an expert witness in a civil action?

A. You'll have to give me a little bit more definition on that.

Q. A civil case, a case where one party is suing or thinking about suing another.

A. If that -- could that involve two companies suing one another?

Q. Absolutely. Any two entities, one of which may sue the other.

A. Perhaps a dozen.

Q. A dozen? Okay. And how many times have you testified in court, except for your testimony in -- before this court?

A. Maybe four or five times.

Q. Okay. Now, you said that you were asked to review the benchmark by, I think you said, an organization called Versar;

is that right?
A. That's right.
Q. And I think you described them as peer reviewers for EPA?
A. They're a company that has a contract with EPA to obtain and coordinate peer review.
Q. Okay. And when you reviewed the benchmark, you didn't have any problems with it, right?
A. Well, I think I have relayed my comments on it, which were that the general methodology seemed to be sound and that I had some reservations and concerns about the misuse of the numbers that were coming out of it.
Q. But you didn't express those reservations, or did you, to the -- well, did you express those reservations to the EPA at the time of the review of the benchmark?
A. I believe so.
Q. Okay. And what did EPA do when it -- did you ever -- were you ever able to locate your comments to EPA?
A. No, I haven't been.
Q. Okay. Did you get a response from EPA?
A. No.
Q. And tell me, as best as you can remember, exactly what you told EPA about the benchmark after your review.
A. Those are the two things that I recall.
Q. Did you do that in writing or orally --
A. In writing.

Q. -- if you remember?
A. In writing.
Q. Now, when did you first acquire the DEP database and start to analyze it?
A. I think I was seeing pieces of it when I first became engaged in work on this subject. So it would have been in the first -- in the *Reylas* case is when I might have first been aware of it and what the data were in it, but -- and I may have had, you know, some of that available to me at that time.
Q. But you never expressed serious concern about those data until your report in this case; is that true?
A. I was aware that -- in the *Elk Run* case, I had begun looking at it in connection with that case, but I had not gone far enough into reviewing it to share with the Court at that time.
Q. But in the *Reylas* case and in the *Elk Run* case, you rendered an opinion that there were factors other than conductivity causing the impairment, right?
A. That's correct.
Q. So that opinion was not formed originally based on your review of the DEP data, correct?
A. It wasn't reliant upon that, no.
Q. Okay. You've read the benchmark pretty carefully by now I imagine.
A. Yes, I have.

Q. More than once, right?
A. Yes.
Q. Okay. And what is the purpose of the benchmark document?
A. The benchmark document, I would say it has two purposes.
Q. Okay.
A. One is to provide a benchmark, which is expressed in terms of conductivity that could be used to judge when conductivity of this nature in waters might be potentially problematic, and I think the other part of it would be to present a case that there's -- that conductivity is playing a role.
Q. When you say it's problematic and it's playing a role, do you think that it was derived to show the level at which conductivity causes impairment as measured by WVSCI and/or GLIMPSS or some metric like that?
MR. MCLUSKY: Your Honor, I object. He's asking him to characterize the benchmark. The benchmark says what it says.
MR. LOVETT: I'm testing his knowledge of the benchmark.
THE COURT: Overruled. It's cross-examination.
THE WITNESS: The benchmark -- it may have been generated by that, stimulated by that, but the benchmark itself is an exercise of looking at genera that are extirpated

at increasing levels of conductivity. So the exercise really is a species or genus sensitivity distribution. That's how it's constructed. It has nothing to do with informing us about GLIMPSS or WVSCI in terms of the benchmark value.

BY MR. LOVETT:

Q. So how was the benchmark value derived?

A. As I just described, from a species sensitivity distribution.

Q. Explain that.

A. Okay. Basically a species sensitivity distribution, or in this case a genus sensitivity distribution, is derived by examining the available data and identifying at what concentrations of something -- it could be anything -- the species are either harmed or not harmed or presumed to be harmed or not harmed by that type of material.

So in the case of the benchmark, the presumption is that it's conductivity; and the way it works is that a list is made of the animals, and a statistical analysis is made of where they're present or absent at different levels of conductivity. And then a line is drawn at a particular percentile to say that at this percentile, we're going to say that this is the benchmark value.

Q. Okay. Now, you criticized the DEP database as containing snapshot data, especially for temperature, I think. Is that fair?

A. I don't really criticize the database because I -- you know, the purpose of the database was not to be doing this kind of exercise, but I criticized the use of the database for this purpose.

Q. Okay. And the use by EPA and others who use it for that purpose.

A. Especially with respect to believing that they have dealt adequately with understanding what else might be affecting the communities.

Q. How many temperature points are there in the DEP database that you reviewed?

A. Thousands.

Q. Thousands. So within that database are more than 3000?

A. At least.

Q. At least 3000 or more data points for temperature, correct?

A. Right.

Q. And when you take all those together, those snapshots add up to a full picture, don't they?

A. Well, as I said earlier, it's a little bit like taking frames from thousands of movies and trying to create a single movie from it; and if you think that that frame tells you what the movie is about, then you're misled.

Q. If you can put them in order, then you can flip through and get a fair picture of the situation, like a movie, can't

you?
A. That's what I've done.
Q. Okay. And that's what you've done. You've taken those snapshots, put them in order, and created a film rather than -- or a movie rather than a --
A. A black and white --
Q. -- series of snapshots.
A. A fuzzy movie, that's correct.
Q. Fair enough. One of those old flip-card things.
A. That's the best that can be done with that data.
Q. Okay. So that's how working with -- that's how one would effectively work, and you did work with a whole lot of snapshot data, right?
A. I worked with it, yeah.
Q. And that's what EPA and King and Bernhardt et al. did too, isn't it?
A. Well, EPA made use of the temperature data; Bernhardt et al. did not. And EPA did not treat the data the way I just described. They left it as a series of frames on the floor.
Q. Do you have the joint exhibit book before you? You probably do somewhere.
A. I have Joint Exhibits 1 through 58.
Q. I think we need 70. I'm not sure of that.
A. 70?
THE COURT: There's another book behind you there.

BY MR. LOVETT:

Q. It would be a series of four graphs or tables. I guess they're graphs. Is that it?

A. They are graphs.

Q. Page JE 954.

A. Got it.

Q. Okay. And I think you started your testimony here by saying that you looked at the temperatures that the animals prefer to live in, right?

A. Yes.

Q. And you divided them into sensitive and tolerant taxa, correct?

A. Those are the two groups I looked at. My groupings were derived from the information provided by EPA and Bernhardt et al.

Q. Did Bernhardt and EPA all agree on which were sensitive and which were tolerant?

A. There was a lot of overlap, but not exact agreement.

Q. And this is sensitive and tolerant to conductivity, correct?

A. That's correct.

Q. So how often were there disagreements between Bernhardt and EPA?

A. I don't recall. We went through a process of where we put the data together and then examined the data to try to get

the most common denominators. We were going to pick 30. So, for example, the *Bezzia* group, you know, that's on here, is I think the one that's considered most sensitive in the Bernhardt paper, but it was lower in the list on the EPA.

Q. Now, the sensitive ones are the *Bezzia* and the *Rhyacophila*? Is that what it is?

A. Yes.

Q. And so those are both sensitive.

A. Yes.

Q. In your grouping, right?

A. In the grouping.

Q. And neither of those are mayflies, are they?

A. No.

Q. Okay. And the tolerant ones are the *Hydropsyche* and the *Rheocricotopus* or something like that.

A. It's a chironomid. *Rheocricotopus*.

Q. Okay. I can say "chironomid."

A. Chironomid.

Q. All right. Now, you in these charts plotted these two sensitive species and tried to show a comparison between those and the tolerant species, right?

A. Right. These are just four of the fifty that I looked at.

Q. And you did that for a three-month period; June, July, and August?

A. Right. I used that window to extract data from.
Q. Why did you use that window?
A. I had looked at the temperature data that I had presented earlier on the patterns in the streams, and I had seen that June, July, and August were very similar in their median temperatures. And so that provided a logical breakout of that period of the year.
Q. And if it's your theory that high temperatures are partially at least responsible for causing the impairment, it makes sense to look at the summer, right?
A. That would be the time of year to look.
Q. So that's not a flaw or a truncation, an illegitimate truncation of the data. It's a way of sifting through the data to make sure it's correct data.
A. That comes down to what question are you addressing, and I was addressing a particular question here, yes.
Q. Okay. Does it take some judgment to determine which of these are -- which of the species are sensitive and which are tolerant?
A. I simply adopted the list that Bernhardt et al. and EPA had put together.
Q. How many of them were there disagreements about?
A. I can go back and look at the list. I don't have it off the top of my head.
Q. You don't remember?

A. No.
Q. Okay. Now, the next figure on Joint Exhibit 71 and 72, the next two, those are exhibits you produced, again the sensitive and tolerant insects, right?
A. That's correct.
Q. Okay. And, again -- or, strike that. Let's move to figure 5, which is tab 73, Joint Exhibit 957.
The plot shows, doesn't it, according to the figure, the description, that there are two groups of insects, sensitive and tolerant, that are distinctly different in their occurrence within temperature regimes; is that right?
A. I'm sorry. I was at the wrong page.
Q. Okay. Page JE 957. And I was reading from the bottom there. "There are two groups of insects that are distinctly different." Do you see that?
A. Yes.
Q. What do you mean by "distinct"?
A. There's one group that has median temperatures that are generally for the summer months that are generally below about 19 degrees, and there is a second group that has their median temperatures that are generally above that kind of temperature. So they -- you know, there's an apparent difference between these two groups.
Q. Did you mean that in a statistical way or did you test for significance there?

A. No.
Q. Do you know of a test of significance called ANOVA, A-N-O-V-A?
A. Yes.
Q. Why did you not use that?
A. I have used that in other parts of this, but I thought these were so obviously different that it was not necessary to do any kind of additional testing on it.
Q. Have you used it in the past?
A. Oh, I have, yes.
Q. It's a common tool?
A. It is a common tool.
Q. Can you tell me, if you know, what assumptions would have to be met to use the ANOVA test here on these data?
A. The assumptions would have to be with respect to normality, variance. And those would be the two main ones. Those could be corrected for through a proper transformation if necessary.
Q. Would you have done that had you had the time?
A. I didn't think it was necessary.
Q. Okay.
A. And, you know, this is really comparing sort of the characteristics of the two groups, not a particular temperature.
Q. All right. Can you tell me -- you took the DEP database

and used it. Did you filter the DEP database in any way?
A. Yes. We looked at headwater streams.
Q. And what's the definition of a headwater stream?
A. About 10 square miles of the watershed area.
Q. So you filtered out any stream that was in the watershed larger than 10 square miles?
A. Right.
Q. And how did you choose 10 square miles?
A. It's based on our review of the literature and our discussions with my other scientists at Exponent. That seemed like a reasonable selection. That includes a lot of the headwater streams in the database, and it excludes the larger water bodies where there may be other things going on.
Q. Did you review any literature to see if that was a definition of a headwater stream or anything like that?
A. It seemed to make sense based on the number of water bodies. It represented the nature of the water bodies in West Virginia.
Q. Okay. Ten-square-mile watershed, how -- do you get third order streams, generally, and how big do the streams get in a watershed of that size?
A. It would depend on a number of factors, but these would be -- tend to be smaller streams.
Q. Second and third order streams, though, surely, right?
A. Second order might be included.

Q. Third order as well.
A. I don't know. It would depend.
Q. Now, Stillhouse is a first order stream, right?
A. Right.
Q. Okay. What else did you filter the data for?
A. For most of our work, that was the main filtering that we did.
Q. Is that the only filter you did for all these?
A. For looking at habitat, we filtered by stream size. So those would be streams less than 10 meters in width; so the smaller streams.
Q. Is that in addition to the 10 square miles?
A. No, that's separate from.
Q. It's probably the case, though, that most of the 10-meter streams are within the 10-square-mile block, right?
A. Well, they tend to be smaller streams.
Q. Okay. How did you measure the 10 meters?
A. They're in the database. So it can be extracted as such.
Q. Okay. How do they -- do you have any idea how DEP measures them?
A. Across the width.
Q. From --
A. Bank to bank.
Q. -- highwater mark to highwater mark or --
A. I think it's bank to bank.

Q. Bank to bank.
A. Yeah.
Q. Top of the bank. Okay. And how did you choose 10 meters?
A. Thinking about Stillhouse and its size, we wanted to -- I wanted to look at small streams. Ten meters seemed to be a reasonable width to capture a majority of small streams.
Q. Did you measure Stillhouse from bank to bank at the point that DEP took its sample?
A. It's about 3 meters.
Q. Three meters? Okay. You measured it?
A. Yeah. I walked it.
Q. That's the only way you filtered the database, right?
A. That's right.
Q. Do you know how Drs. Palmer -- excuse me -- Bernhardt, King et al. filtered their database?
A. I do, and I use their database as well. So, you know, that was part of my analysis.
Q. Okay. And what did they filter for?
A. They used basically a subset of the EPA database, which was filtered. I don't know whether they used that database directly or just applied some of the criteria that EPA utilized. And then they further filtered it to exclude development in their watershed that would exceed something like around 4 percent. So they wanted to be exclusively

looking at mining.
Q. They filtered urban development, right?
A. Yes.
Q. Because that raises the water temperature significantly, doesn't it?
A. Yes, of course it does.
Q. Because there are paved surfaces, and water that runs off hot paved surfaces is about the hottest water you're going to get, right?
A. Any place in the watershed where you have a town, a parking lot, a farm, anything like that is going to raise the water temperature.
Q. So if you're looking at mining impacts, it makes sense to filter those sites out, doesn't it?
A. If that's all you're looking at.
Q. And they also filtered the database, didn't they, for the ecoregion?
A. Yes.
Q. You didn't do that, did you?
A. No.
Q. So how many ecoregions are included in their database -- excuse me -- in the data that you used from the database?
A. Well, the majority are the same ecoregions, plus basically West Virginia as a whole.
Q. Okay. So that includes the eastern mountains as well as

the coal-producing counties, right?
A. Right.
Q. Streams are much different in those mountainous areas up in, you know, Pocahontas County or Tucker County than they are in, say, Logan or Mingo County, right?
A. Well, I had reviewed the WVSCI development document. There's very little difference that matters between these regions. It's a small -- it's a small source of variance from what I was looking at.
Q. Really?
A. Yes.
Q. And what were you looking at for which there was a small source of variance?
A. Basically the development of the WVSCI and community structures, so -- that's in the WVSCI development document.
Q. What about water temperatures?
A. Water temperatures can vary, certainly.
Q. Water is much colder in the eastern mountains at 3500 feet than it is down near a river in Southern West Virginia, isn't it?
A. Well, what I was interested in looking at are the water temperatures in which the animals are found, and that's specifically genus. So it's much -- makes much more sense to be more open about that, but within West Virginia, than it is to exclude stuff.

Q. Now, you criticized EPA for extending the temperature range of reference streams to -- I believe it was 30.6 degrees; is that right?

A. I'm not sure it was a criticism. It was an observation that such a number, which I think they may have gotten from some kind of source, was really irrelevant for judging the effects of temperature --

Q. Uh-huh.

A. -- on WVSCI. It just makes no sense.

Q. And it makes no sense because reference streams aren't that hot.

A. That's correct. They tend to be 10 degrees cooler than that.

Q. Okay. And that's based on your review of the data that you -- from the DEP database?

A. It's actually based on data from the database.

Q. Let's turn to tab 75, please, which is page JE 959.

Now, all of the ecoregions are included in these, correct?

A. Correct.

Q. And it's also the less than 10 meters wide, correct?

A. Right. Those would be, as we described -- and, of course, we have the Bernhardt data, which is very specific.

Q. Right. Is it filtered -- is all the data here filtered like the Bernhardt data? Only the data on the right-hand box

is the Bernhardt data. The other two are the All Records and unfiltered or the Less Than 10.

A. Right. It allows you to look across and compare right across the panels.

Q. Did you test for statistically significant differences within each of these groups?

A. No.

Q. Why not?

A. I was using this as a pictorial to take a look at the likelihood of being above and below a score of 68, but I did not do any statistical tests as to the likelihood of being above or below 68, but you can see by eye what it is.

Q. For the All Records and the Less Than 10 Meters Wide groups, what were the sample sizes within each category?

A. I don't know that number off the top of my head.

Q. Well, do you have it here somewhere so you could tell us?

A. I could -- I could provide it tomorrow.

Q. You can provide it tomorrow?

A. Sure.

Q. Okay. You'll probably say the same thing for the next question, but for all the records -- for the All Records and Less Than 10-Meter Wide groups, what were the sample sizes within each category?

A. I can provide you with that tomorrow.

Q. Okay. Thank you. Also, I'm a bit confused. If the RBP

data are unreliable in the way you describe them, why do you use them here to test for what -- you know, why do you use them here?

A. Well, first of all, there's nothing else available.

Q. Uh-huh.

A. And then, secondly, what I did was not use the individual values but the broad characterizations that the RBP reflects. So if a lot of things are going all right with a stream, its conditions are optimal, then, you know, a lot of the factors that might be compromising the stream are on the good side of the equation.

If, on the other hand, a number of things are going potentially wrong with the stream, then they're on the other side of the equation. So these categories of optimal and marginal provide a way of getting at whether or not habitat is important --

Q. Uh-huh.

A. -- without relying on an individual RBP value, which I consider to be highly unreliable.

Q. But because it relies on RBP data, which you described well, I think, in the Stillhouse example where there was a score of 2 for embeddedness and 18 for flow or some other category, and your testimony is that it's that embeddedness that is the important number there and that averaging them together really skews the understanding of the stream, right?

A. Right.
Q. And that's true across RBP scores.
A. That's correct.
Q. So this isn't a very useful chart, is it, because it's based on those unreliable RBP scores?
A. As I said, I didn't rely on any one score. I grouped them into characteristics that were a lot of things were good, a lot of things were not so good, without trying to understand which of the things might be important to the habitat or which score might be important. So I've looked at the scores, and I recognize that there's an enormous uncertainty about any one score.
Q. A group of unreliable scores is still unreliable, isn't it?
A. They're unreliable as individual scores.
Q. Why are they not -- why are not a group of unreliable individuals unreliable as a group?
A. Well, that's why I contrasted optimal and marginal, poor conditions, so it could show that if you were to spread this apart, you would -- and take a look at whether habitat matters or not, you'd be able to see it, as opposed to trying to do a regression or something with individual RBP scores.
Q. The remarkable thing to me here is that you left out the suboptimal category. Do you know how many -- let's look at the Bernhardt data, for instance. Do you know how many of the

streams -- well, first of all, do you know how large the dataset was for that for RBPs?

A. I think -- for the Bernhardt data?

Q. Uh-huh.

A. I think somewhere in the neighborhood of -- I might confuse it with my own numbers and stuff, but maybe in the neighborhood of 400.

Q. Okay. I think it's smaller than that, but I'm not sure.

A. Maybe 223, something like that.

Q. Of those, do you know how many were optimal?

A. Not off the top of my head.

Q. I'll tell you what I think, and I just asked and got these answers. You tell me if they sound right to you.

Optimal would have been at 58. Poor or marginal together would have been 28. And suboptimal, there were 137 sites.

So you left out two-thirds of the sites, didn't you?

A. Well, I was contrasting obviously marginal and poor with optimal in this.

Q. Yeah, but how can you do that? I mean that doesn't give you -- that so skews the data that -- well, strike that.

How can you know -- if it's an imprecise measurement, how do you know that something that was labeled suboptimal shouldn't have been optimal for your purposes, or vice versa?

A. I think there's enormous subjectivity in those numbers.

Q. So it doesn't make sense to me that you would eliminate

the largest -- by far the largest category from your assessment given that all of the measurements are unreliable. Why did you do it?

A. Well, I've continued the analysis on this, and I have looked at the influence of these various categories together with temperature on WVSCI. So I have an even deeper understanding of how temperature and habitat work together for suboptimal, optimal, and marginal.

I think that's the kind of work that's needed to really resolve some of this.

Q. More work is needed to resolve it?

A. Well, what I've seen is that combinations of habitat that's either suboptimal or marginal and elevated temperatures will lead to lower WVSCI scores.

Q. Did you do that box plot, or whatever that's called, the last number at page JE 959, did you do that with the suboptimal included at one point and then --

A. No.

Q. You did not?

A. Never.

Q. Let's turn to tab 77, which is at JE 961. Do you see that?

A. Yes.

Q. The Stillhouse data I think you described just now as there was twice-monthly sampling of temperature data there?

A. Yes.
Q. How long has that been going on?
A. I don't know how long it's been going on. I think this represents years' worth of data, but I don't know when they initiated it.
Q. You used one year's worth of data?
A. A couple of years. So at least two or three years' worth of data.
Q. How many years of data did you use?
A. I think three.
Q. What years?
A. Recent years. So maybe the most recent is like around 2012, 2011, somewhere in there.
Q. So the quality of that data, would you consider that good quality data?
A. I think it's pretty representative over, you know, a number of years and a couple of times a month to kind of give a feel for what the temperatures are in the pond.
Q. Could you tell me the years that you used tomorrow?
A. Sure. I'll get that for you.
Q. Now, the West Virginia -- the other data all comes from the West Virginia database, right?
A. Yes.
Q. So you're comparing the snapshots from the database with this more complete record of sampling from Stillhouse, right?

A. Yes. I've put the snapshots together so that they are organized by month.
Q. Uh-huh.
A. So they can give us a picture of what -- you kind of think of all the snapshots as random measurements carried out in waters of a particular characteristic over years and locations. For the month of June, for example, that's what that represents. So they'll have possibly hundreds of measurements in it.
Q. So you're comparing the database from West Virginia that includes ecoregions not within this ecoregion, right?
A. Uh-huh. Correct.
Q. And urban catchments included in that, right, snapshot data, with a very specific set of numbers?
A. Well, my dataset are all small watersheds.
Q. Uh-huh.
A. They're not urban catchments, and, you know, we're not looking at towns here. We're looking at headwaters.
Q. Ten square miles.
A. Ten square miles or less.
Q. That's the only filter.
A. That's correct. And for the reference dataset, those are the reference water bodies of the state. So that's what the state relies upon as the reference dataset.
Q. Okay. And do you think that what the state relies on is

the right thing to rely on?
A. I think so for getting the baseline of what reference water bodies look like.
Q. Okay. Let's turn to the joint exhibit book, the second joint exhibit book, to tab 58 of that book.
I don't think it's in that one.
THE COURT: Volume 1?
MR. LOVETT: I believe it's Volume -- yes, it is Volume 1, the first volume.
Don't take that one too far away.
THE WITNESS: Did you say Exhibit 58?
MR. LOVETT: Pardon?
THE WITNESS: Did you say Exhibit 58?
THE COURT: It's split into two volumes. So you're looking for Joint Exhibits 1 through 58.
THE WITNESS: Got you. That would be this.
BY MR. LOVETT:
Q. Okay. Would you turn to Joint Exhibit page 493.
A. Got it.
Q. Now, this is where -- it's number 5. EPA says that West Virginia limits for reference sites are 30.6 degrees or less, right?
A. Right.
Q. And Stillhouse, I think your highest reading there was about 24?

A. Probably around there, yeah.
Q. Which is much lower than at least EPA purports that the West Virginia limits for reference sites are, right?
A. It's higher than -- it's lower than 30.6 degrees.
Q. Significantly lower.
A. Yes.
Q. Do temperatures have to reach a lethal range to show a shift in the WVSCI in your view?
A. No.
Q. Okay. Because you think that when you get at a certain level -- what? -- bugs go somewhere else and WVSCI decreases?
A. Well, aside from WVSCI, all animals would -- including ourselves -- will have temperatures in which we want to live or find appropriate for ourselves. And bugs are no different. Bugs in particular, because they're cold water animals, will live in waters with particular temperature regimes.
Q. And when you used in your work -- when you determined a reference stream under the West Virginia DEP, you used the DEP database to decide what was a reference?
A. They specify what the reference streams are.
Q. And they have different levels of reference, don't they?
A. Yes.
Q. And how many levels are there?
A. Three.
Q. And you didn't use all three levels, did you?

A. No.
Q. You didn't tell us that here, though. Why not?
A. I used reference level 1. Basically those are the majority of the ones that are considered the good reference areas.
Q. Well, why didn't you specify that until just now when I asked you? Isn't that an important distinction?
A. It's in my figures. It's in the report.
Q. It's in your report?
A. Yes.
Q. Okay. What are the -- why did you choose to use only reference level 1 instead of 2 and 3 as well?
A. Because I know from viewing the development of the reference dataset that reference areas 2 and 3 are reference areas that are compromised in various degrees.
Q. I'm sorry.
A. So they're not as good quality environments as are reference area 1. Reference area 1 have samples or areas of -- the kinds of areas that the WVSCI was developed from.
Q. Is that true, or was the WVSCI really derived from all three levels?
A. I think it was derived from level 1. That's my understand anyway.
Q. But if it wasn't derived from level 1, that's a problem for you, isn't it?

A. No, I don't think so.
Q. You don't?
A. I don't believe so, no.
Q. Okay. Now, you said just now that you rely on DEP to determine what a reference stream is in West Virginia. You just testified to that, didn't you?
A. Yes.
Q. And it determined that levels 1, 2, and 3 are all reference, correct?
A. It has some 2's and 3's, but most of them are reference level 1's.
Q. But there are three levels of reference streams, right?
A. Right.
Q. Now, do you know what the mean summer temperature is in reference level 1?
A. The mean?
Q. Uh-huh. Yeah, the mean.
A. I don't know what the mean is. I know what the median is.
Q. What's the median?
A. If we can go to my report, it would be on there.
Q. Okay. I don't know where your report is. Maybe -- we'll see if we can find it here.
A. The mean would be really the wrong statistic to use for this kind of thing, but I can tell you the median.

Q. Okay. We're going to find them now. I'm going to ask you the maximum too, and I expect that's in the same place, right?

A. That's correct.

MR. LOVETT: I think that the report is not a part of the exhibits for the case, but I have a copy of it. If I can approach.

THE COURT: You can refresh his recollection.

BY MR. LOVETT:

Q. So I've handed you what I believe is the report you're talking about, a copy of it.

Could you tell me from that what the mean summer temperatures are for levels 1, 2, and 3?

A. Well, as I mentioned, the mean would be an inappropriate statistic to use here.

Q. Or if you have median instead.

A. So the median value, if --

Q. Could you tell us what page of the report you're referring to?

A. Page 8.

Q. Okay.

A. And I see that the median for the warmest month, which is July, is somewhere around 18 degrees.

Q. And that's in level 1?

A. Yeah, that's reference level 1.

Q. Okay. And how did you determine that?
A. From the statistical analysis of the database.
Q. Did you do a statistical analysis on the database to reach that conclusion?
A. This box and whisker plot indicates that the median is about 18 degrees.
Q. And how did you -- how did you -- tell me the procedure you used to determine that that was the median.
A. Well, basically for the West Virginia database, all the values that are available for July are taken as one set of data.
Q. Okay.
A. And so the median, then, is the 50th percentile of that dataset.
Q. So you took every piece of data from the West Virginia dataset, filtered for less than 10 square miles, or not?
A. Well, this would be -- yes, this would be -- and I'll check that for you specifically, but this is for the reference level 1 dataset that we have in here and that, you know, was provided to you. And I see the median value for July from my figure at about -- it looks like it's about 17 or 18 degrees.
Q. Okay. 17 or 18?
A. Somewhere in there.
Q. Why is the mean incorrect, improper, and the median is the right one?

A. Because we're talking about frequency, you know, numbers of streams. We're not talking about -- an animal, for example, doesn't experience the mean temperature of all the streams.

Q. Okay.

A. It only experiences the temperature in a particular stream.

Q. Fine. Thank you. And for level 2, what is the median, then?

A. That's not calculated on here.

Q. It's not?

A. No.

Q. You don't know the answer?

A. No.

Q. Do you know the answer for level 3?

A. No.

Q. Do you know what the maximum temperature is on level 1 in the summer months?

A. For level 1, in July, the maximum temperature was about, roughly, 22 degrees.

Q. And what about level 2?

A. I don't have level 2 or level 3.

Q. Okay. So it's not fair -- okay. It's not then true that -- strike that.

Now, how many sites did you use from the database here,

how many total sites?
A. I'll get you the number, but it's upwards -- in terms of samples, it may be in the low thousands.
Q. In terms of total sites, how many total sites did you use?
A. I'll provide you with that in the morning.
Q. Okay. Do you know about what percentage of the sites in the DEP database that you used for about what percentage of the total sites you used?
A. By that, do you mean how many sites in the database were reference sites that I may have used, like what percentage of the sites or -- or if we screen by less than 10 square miles, what fraction that is of the total?
Q. Of all the temperature assessments that you did, how many sites were there, if you know?
A. We'll get that to you --
Q. Let's just wait until tomorrow.
MR. LOVETT: Your Honor, I have several questions that follow on this, and I know it's five minutes early, but this would be a good place to quit so we can start with those data.
THE COURT: All right. We'll go ahead and stop. We'll resume at 9:00 a.m. tomorrow.
You may step down. Don't discuss your testimony.
THE WITNESS: Okay. Thanks.

THE COURT: I'd like to see counsel informally here, but we'll stand in recess and we'll reconvene at 9:00 a.m. tomorrow.

(Proceedings adjourned at 4:53 p.m.)

I N D E X

Defendant's Exhibits

No. 1 Kuehn expert report, Figure 1 648

No. 6 Menzie report, Appendix E 646

I, Teresa M. Ruffner, certify that the foregoing is a correct transcript from the record of proceedings in the above-entitled matter.

/s/Teresa M. Ruffner September 15, 2014